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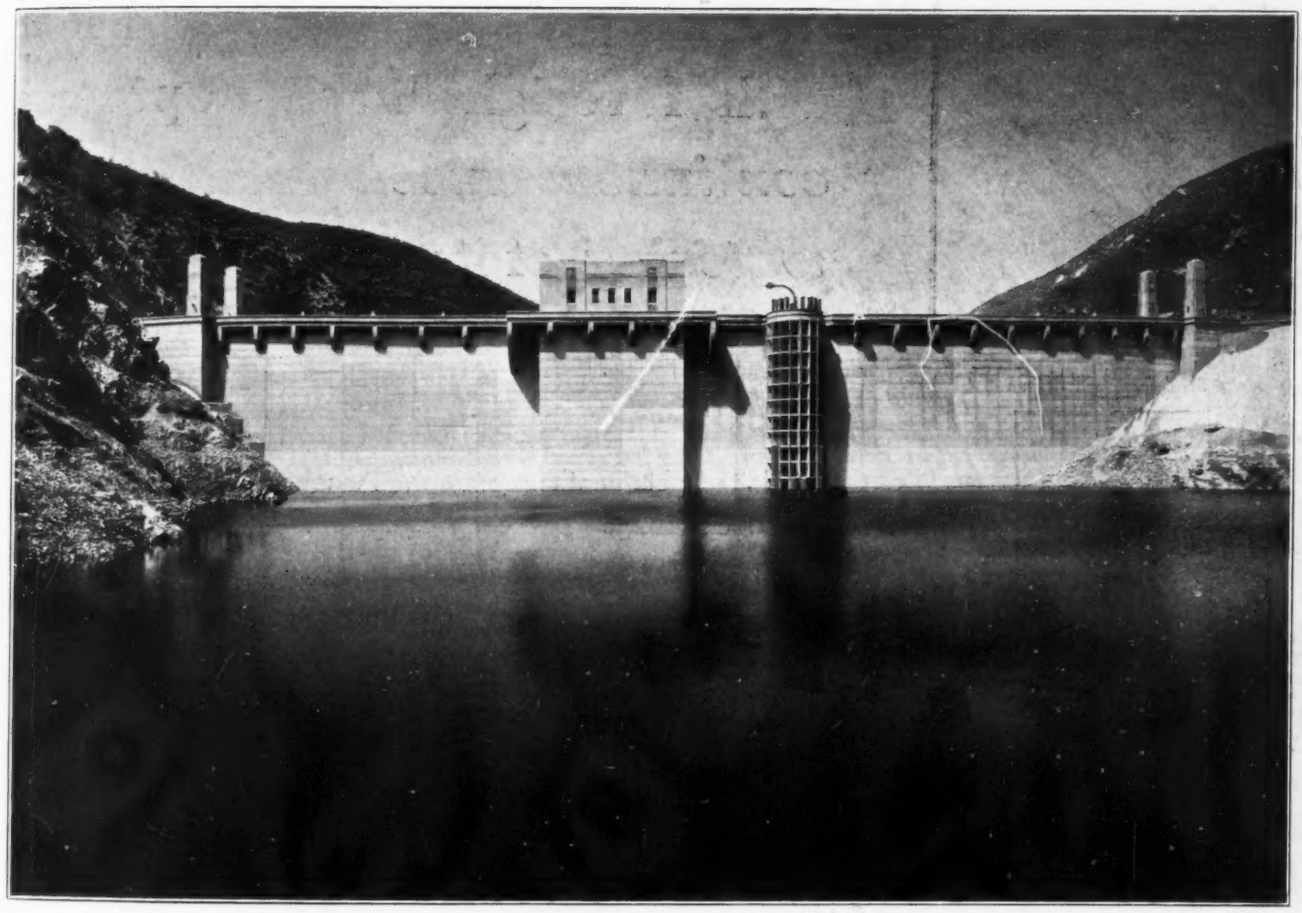
# WATER WORKS AND SEWERAGE

July, 1934 Vol. LXXXI. No. 7



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IN THIS ISSUE

Ferric Sulphate Coagulation
Improving Sewage Plant Operation
Treating Water with Aid of Magnesium
Hourly Load Variations in Sewage Treatment
Report of 54th Annual Convention American Water Works Association
Water Purification Topics at American Water Works Association Convention

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★ Rockford Mich

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WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

## LEADING ARTICLES To Appear in the Next and Subsequent Issues:

J. R. Rumsey, Superintendent, Sewage Treatment Works, Grand Rapids, Mich., will report on experiences with power production during the past year by use of gas engines operated on sludge gas at the Grand Rapids plant. Costs and performance are carefully analyzed.

A. S. Behrman, Chemical Director, International Filter Company, is to relate and discuss "Recent Developments in Municipal Water Softening" in the next issue.

P. N. Daniels, Superintendent, Sewage Treatment Works, Trenton, N. J., will describe a new and simplified scheme of shedding partially digested sludge cake, in fertilizer production.

W. L. Eisert, Manager, Riverton (Pa.) Water Company, in an article on "Advertising" recounts successful methods of building consumer and community good will for the local water utility.

C. H. Capen, Consulting Engineer, West Orange, N. J., will compare fees paid water companies by municipalities with those, if any, allowed water departments to cover fire protection charges. Unfairness to water departments, not granted payments for fire protection, will be shown by citing case records covering both classes of water supplies.

L. F. Warrick, Chief Engineer, of the State Board of Health of Wisconsin, will describe successful methods of treatment of milk wastes and canning wastes, developed and adopted in Wisconsin as the most practical available processes of treatment. Results and costs are cited.

J. E. Herring, Superintendent of Meters, Jacksonville (Fla.) will tell of methods employed in the operation of Jacksonville's Meter Department; describe field and shop practices of maintenance, testing and repairing.

C. E. Keefer, Engineer of Sewage Treatment, Baltimore, Md., will compare actual costs of sludge dewatering operations at Baltimore with the ordinary vacuum filtration scheme tried and the greater economy of the sludge elutriation-filtration process recently developed at Baltimore.

T. M. Riddick, Sanitary Engineering Department of New York University, will continue his series of articles describing homemade laboratory equipment—the next being a flocculating (stirring) apparatus.

P. S. Wilson, Consultant in Water Works Practice, Glen Ridge, N. J., will continue a series of articles dealing with "Hydraulics." In this series, especially written for the practical water works operator, "Making Fire-Hydrant Discharge Measurements and Their Application to Operating Problems" is the topic to be presented next.

John R. Baylis will continue his discussion of "Filtering Materials for Rapid Filters"—methods of testing and properties of various filtering materials will be next discussed.

John R. Downes, Superintendent, Sewage Treatment Works, Plainfield, N. J., will report the results procured and cost of partial chemical precipitation, to reduce the loading on the biological secondary treatment at the Plainfield works. A second article by Mr. Downes will cover operating data and costs of sludge dewatering by the centrifugal spray-drying process recently installed at the Plainfield plant.

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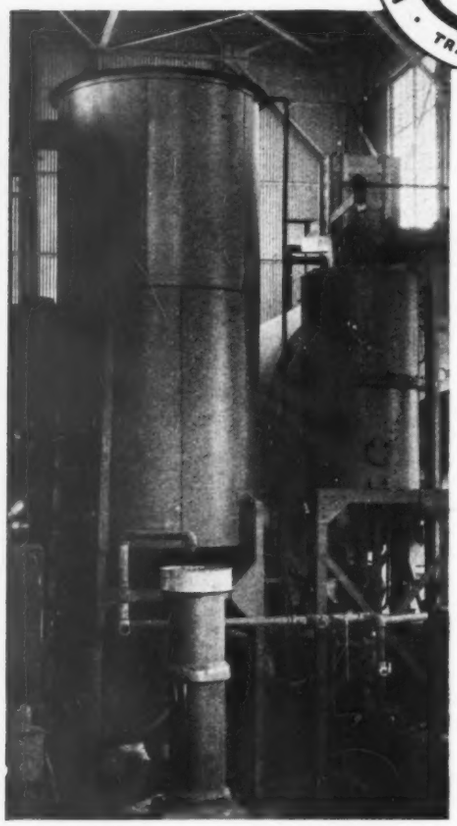

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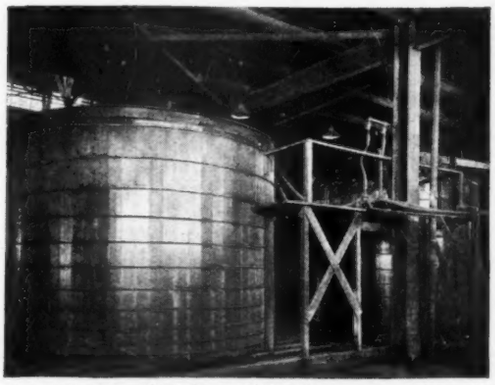

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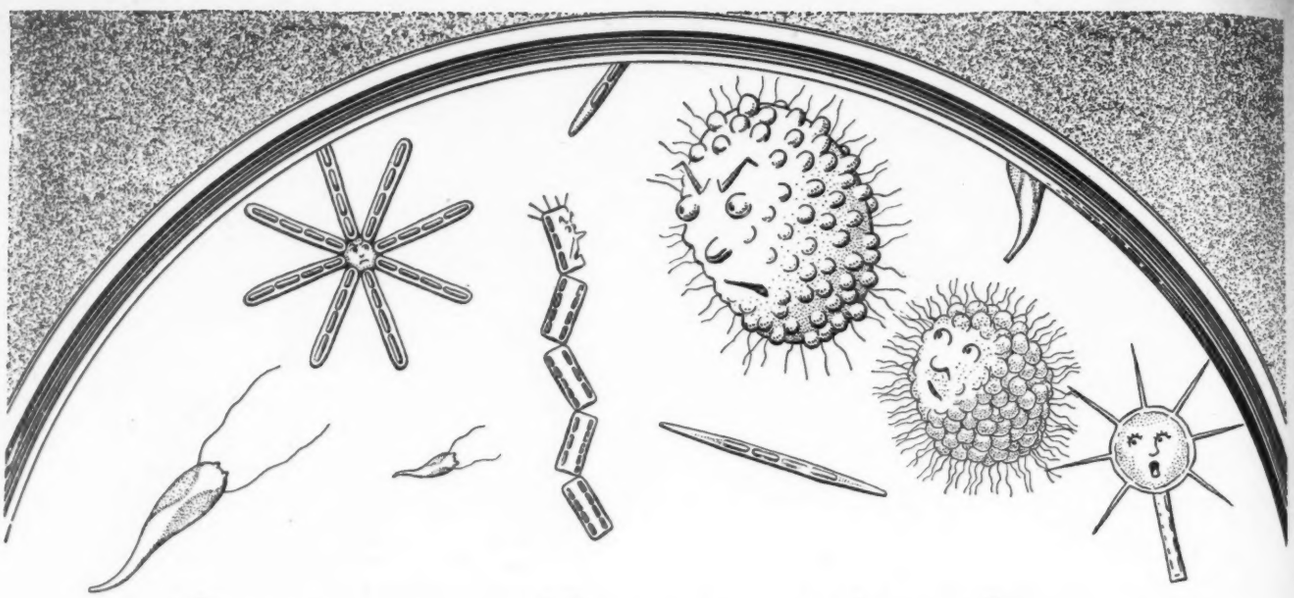

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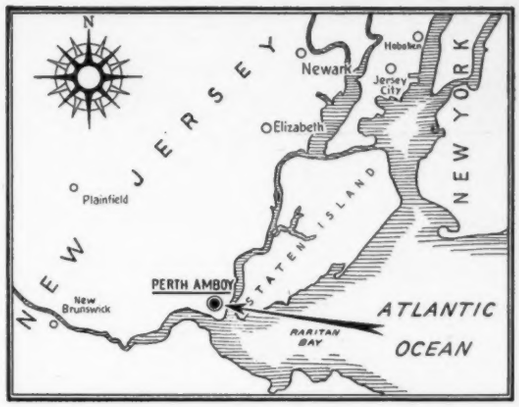


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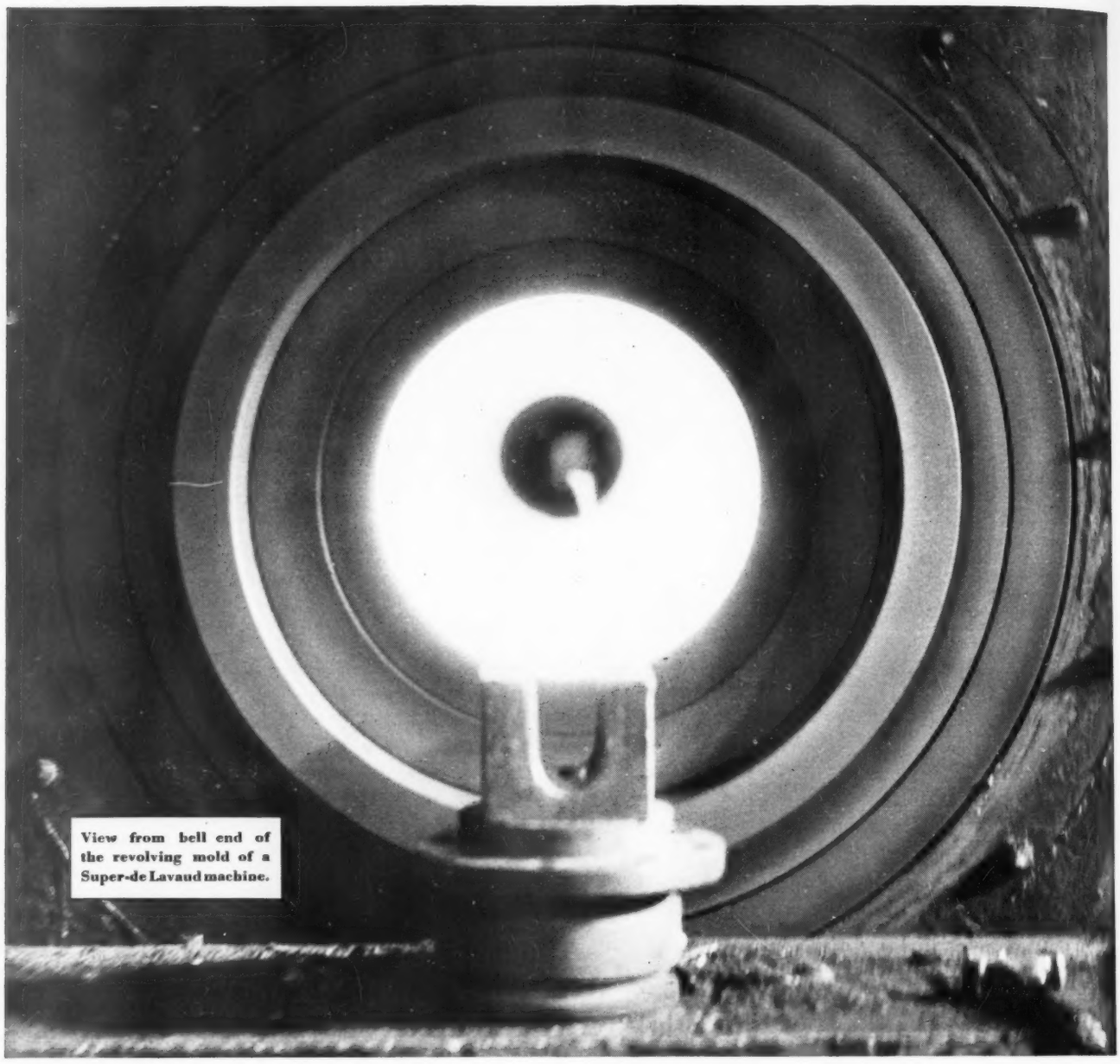

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WATER WORKS AND SEWERAGE
JULY 1934
NO. 7
VOL. 81
A GILLETTE PUBLICATION

# FERRIC SULPHATE COAGULATION

By PHILIP J. HOLTON, JR., and ELWOOD L. BEAN*

INTEREST in iron coagulation has developed rapidly since the first production of ferric iron by the simple process of chlorinating a copperas solution. Publication of studies, together with rapid developments in the line of production and availability of ferric compounds in desirable physical form, have greatly increased this interest. Experimental runs have been made on a plant scale by many water-works and ferric coagulation has been adopted for continued use in several instances.

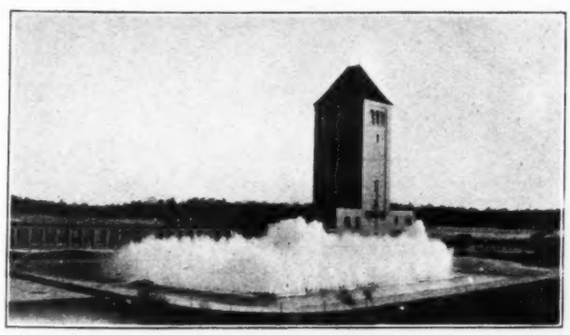
In consideration of any process these questions arise: When and where should the process be applied and what advantages or disadvantages will attach to its application? Also, how can the process be controlled and economically applied? In an article previously published,[1] an outline was given of the conditions and purposes leading up to the adoption of ferric iron as coagulant at Providence. In a recent article[2] one of the authors discussed many points relating to the applicability of ferric compounds. In the present instance it is the intent to outline and discuss methods here employed in the application of ferric sulphate and the results obtained by its use.

The main purpose in treatment of water at Providence is five-fold; namely, the removal of color, iron, manganese; and, the production of a non-corrosive and stable effluent. These purposes must be accomplished without undue increase in hardness or other impairment of water quality with respect to its use in homes, laundries and commercial processes. Alum coagulation accomplished the removal of color and iron. Copperas (ferrous sulphate) and lime treatment removed manganese and prevented corrosion but the iron content of the effluent was higher than with previous treatment, also hardness was doubled. Chlorination of the copperas reduced the iron content of the effluent to a low figure and resulted in materially reduced hardness. The more recent change to commercial anhydrous ferric sulphate and lime has shown this treatment to possess the combined advantages of former treatments.

*Superintendent and Chemist, respectively, Scituate Reservoir Division, Dept. of Public Works, Providence, R. I.

[1]WATER WORKS AND SEWERAGE, Volume 79, No. 9, p. 301-4.

[2]Jour. N.E.W.W.A., Vol. 47, No. 3, p. 273-9.



*Raw Water Aerators and Filtration Plant, Providence, R. I.*

## Factors in Solution of Ferric Sulphate

Dry commercial "Ferrisul," the material being employed, contains approximately 94 per cent of true ferric sulphate. It is very soluble in limited volumes of water but not in dilute proportions, therefore methods commonly employed for dissolving ferrous sulphate or alum in tanks or as fed from dry feed machines are not suitable for use with the ferric sulphates. If batch mixing is practiced proportions approaching 40 per cent of chemical can best be used, greater strengths may not be readily handled due to their viscosity. In continuous solution of the discharge of dry-feed apparatus the same upper limit applies.

Ferric sulphate on going into solution produces considerable heat which assists solution when the water

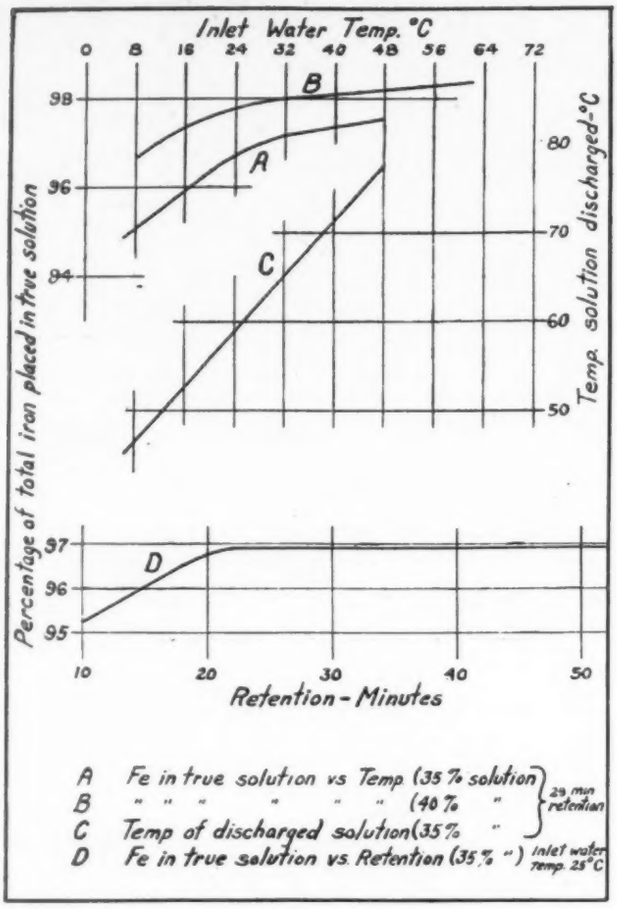



*Fig. 1—Solubility Curves for Anhydrous Ferric Sulphate*

volume is not too great and therefore this value is not fully realized when dilute solutions are prepared.

Since the percentage of chemical passing into complete and, therefore, effective solution is a function of temperature it is of prime importance that the volume of water used should be kept as low as possible to effect efficient utilization of the heat of solution.

Curves A and B on Fig. 1 show percentages of the total iron which are placed in true solution, with 35 and 40 per cent respectively of chemical and 65 and 60 per cent of water (by weight) at various temperatures, in solution apparatus described below. Curve C shows the temperature as found of the discharged solution. Since no correction has been made for radiation losses, this curve does not indicate the total heat released in the process of solution. Curve D indicates that a minimum of 20 minutes retention within the solution tank or chamber is required with a 35 per cent solution and proper temperature control. Greater retentions produce no added effects of material consequence.

From curve A it will be noted that with increasing temperatures of inlet water up to 25° C., the percentage placed in true solution increased rapidly; and, then very slowly above that point. An increase in temperature of 18° C. on the inlet water caused 2 per cent more of the chemical to pass into true solution. This is equivalent to 40 pounds out of each ton of chemical representing a value of 64 cents. When this temperature rise is produced by electric heat input to the minimum volume of water practical to use the cost of current is 18 cents. It is, therefore, economical to raise the temperature of the inlet water by electric heat, should warm water not be available from other sources at less cost.

## Chemical Feed and Solution Apparatus

Although the original design of the plant, as a whole, was well suited for handling the new chemical, slight modifications to our present equipment were required in order to properly and most economically utilize this new coagulant. Of necessity we were compelled to change the drive end of the dry feed machines and the chemical feed line had to be replaced. The old single phase a.c. motor, with a speed range of 900 to 1800 r.p.m., driving a set of seventeen change-gears, was subject to frequent breakdowns and the cost of rewinding this particular type of motor exceeded the cost of a new drive. The cast-iron chemical feed line had deteriorated considerably due to the feeding of chlorinated-copperas which the line was never designed for. Under the circumstances, we would not be justified in charging these replacements directly to the cost of handling the new chemical. In the design of the new equipment, however, materials best adapted to this work were selected.

The new drive (Plate 1) on the chemical feed machines consists of a variable speed unit with direct connected, 550 volt, 3 phase, a.c. motor, ½ h.p. capacity at the drive end of the shaft, and a speed range of 175 r.p.m. to 1,222 r.p.m. This connects through a flexible coupling to a 80 to 1 gear reduction unit which in turn drives two sets of change gears. Operating on one set of gears we obtain a speed variation at the screw of 50 r.p.m. to 7 r.p.m. and the other set provides a variation of 7 r.p.m. to 1. This gives an overall speed ratio of 50 to 1 which can be obtained while the machine is in operation simply by sliding the key from one set of change gears to the other. On the previous drives we were confined to a speed ratio of 10 to 1 which did not furnish sufficient flexibility for operating under all rates. At present we do not require the extreme ranges,

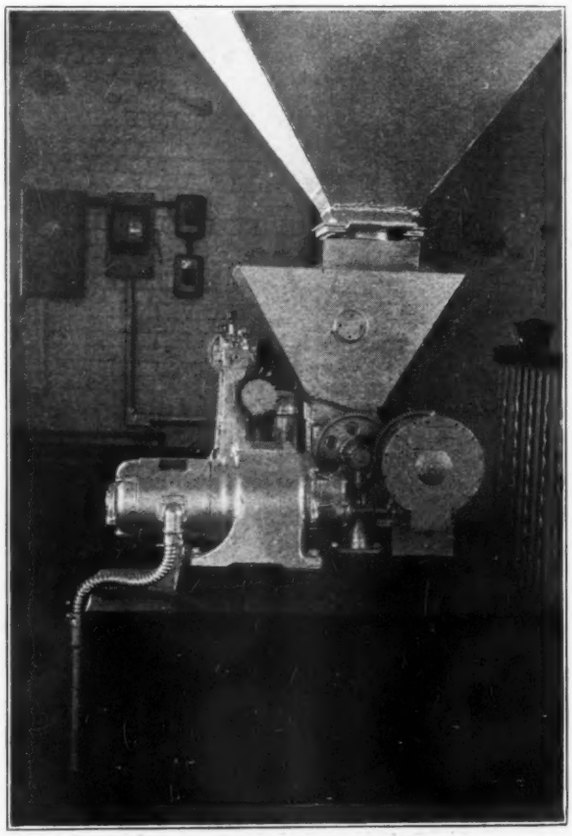


*Plate 1—Ferrisul Feeder Showing Variable Speed Motor and Reduction Gear; Speed Variation 50 to 1*

*Plate 2—View of Hot Water Pump Automatically Maintaining Ratio of Water to Ferrisul Delivered to Rubber Lined Solution Tank. Note Portable Mixer Clamped to Flange of Dissolving Tank*

which may be obtained, but the equipment is designed for the ultimate capacity of the plant and no additional expense was involved for this wide range of operation.

The solution tanks are of welded steel construction with a baffle compartment, into which the chemical and water are introduced, which runs for the entire depth and opening into the main tank at the bottom. Each tank (Plate 2) has a capacity of 30 gallons, which provides ample storage for the necessary retention (twenty minutes when dissolving in proportions of 35 per cent chemical) to care for 370 pounds of chemical per hour or 4.5 tons per day. The tanks are lined with rubber 3/16 inch thick and necessary precautions were used in selecting the density of the rubber to prevent any disintegration from chemical reaction. The stock was applied in two applications of equal thickness. The cushion stock applied direct to the metal has a density of approximately 200 plastometers and the second application, or face stock, has a density of 10 plastometers. Lead lining was considered for the tanks but the excessive cost could not justify adopting this type of construction.

The apparatus for controlling the quantity as well as the temperature of the warm water for dissolving the "Ferrisul" is extremely simple. A small 1¼ by 2 inch single acting triplex pump placed on the same base with the drive is driven by a chain and sprocket from the shaft of the screw feed (Plate 2). Thus any change in the speed of the dry feed apparatus automatically increases or decreases the speed of the pump, thereby insuring a constant proportion of water to chemical under all conditions. The pump suction is connected to a small porcelain tank elevated to maintain a constant head on the pump to prevent possible loss of suction. The warm water to the porcelain tank is usually furnished from the hot water system but in case of failure an auxiliary electric heater, thermostatically controlled and connected into the cold water system, furnishes the hot water to the tank.

Mixing of the solution is obtained by a small portable mixer (Plate 2) with a direct connected, fully enclosed, ball bearing motor clamped on the flange of the tanks. Downward thrust propeller blades attached to the shaft drive all the solids from the tank bottom, turn the entire fluid body over and over from bottom to top, thereby securing excellent mixing.

In replacing the chemical feed line, careful study was made of the different materials suitable for this installation, with the result that rubber lined (⅛ in. thickness of 200 plastometer density) flanged pipe, valves and fittings were finally selected. The rubber lining was carried

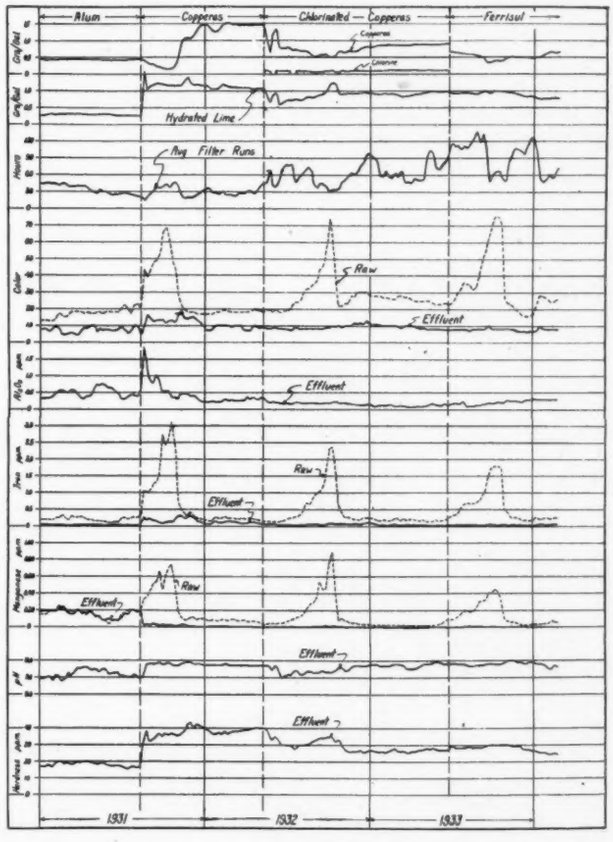


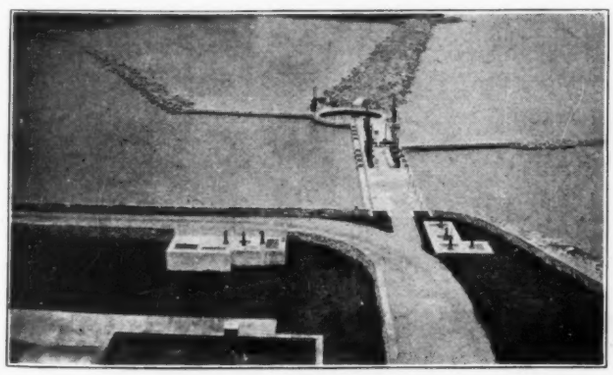

*Fig. 2—Comparing Results from Use of Three Different Coagulants*

on to the face of the flange and fittings, thereby forming a gasket and at the same time preventing the liquor from attacking the metal. Provisions are made for introducing the coagulant before or after raw water aeration, and where the Ferrisul solution is discharged into the conduits both drop pipes are lined on the outside as well as the inside. Special rubber lined valves designed for this service were installed in the drop pipes to control the point of treatment.

The tabulation in Table I shows the entire cost of changing over all three dry feed machines in order to adopt the Ferrisul treatment.

TABLE I

| | |
|---|---|
| 3 Variable Speed Machines and Electric Controls, $175.32 each | $ 525.96 |
| 3 Triplex Pumps, $76 each | 228.00 |
| 3 Sets Gears, Bearings, Shafts, etc., $34.60 each | 103.80 |



*Tangential Flow Circular Mixing Chamber (Center) Between Two Coagulation Basins*

| | |
|---|---|
| 3 Welded Steel Tanks, $25 each | 75.00 |
| Rubberlining 3 Tanks, $54.54 each | 163.62 |
| 3 Lightning Mixers, $38 each | 114.00 |
| Chemical Feed Pipe, Fittings, etc | 188.87 |
| Rubberlining Chemical Feed Pipe, Rubberlined Valves | 341.30 |
| Electric Heat Controls, etc | 72.91 |
| Brass Pipe for Hot Water System | 60.22 |
| Total | $1,873.68 |

"Ferrisul" is received in granular form in wooden barrels, delivered by truck. It is dumped into a bucket conveyor elevating it to the concrete storage bins. Each bin has a capacity of approximately forty tons of chemical and is constructed with sloped sides to an outlet of seven inch diameter. Not the slightest difficulty has been experienced in the storage of Ferrisul.

To prevent the rapid hydrolysis of ferric sulphate, which takes place in very dilute water solutions, the coagulant is carried in solution of strength not less than one percent of chemical from the continuous solution tanks to the point of introduction into the raw water. This coagulant is introduced directly into the raw water as was the practice with previous iron coagulants. Dosed water is aerated and then treated with hydrated lime to

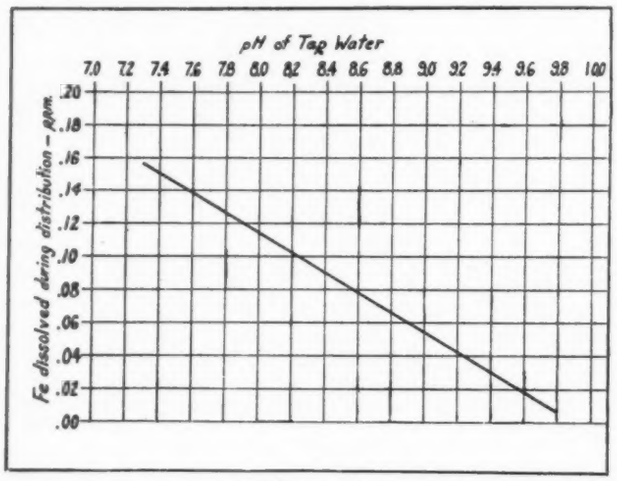



*Fig. 3—Effect of pH of Filtered Water on Corrosion of Pipe System. (Note That in Such a Mineral-Free Water as This at Providence, Corrosion Cannot Be Stopped at pH 8.4, But Instead It Is Necessary to Maintain a pH of 9.2 to 9.6 to Produce a Satisfactory Tap Water)*

the point of slight causticity, i.e., phenolphthalein alkalinity slightly in excess of one-half the methyl orange alkalinity. Then follows thorough mixing and approximately a two-day sedimentation en route through the basins to the rapid sand filters.

Hydrolysis of the ferric sulphate occurs at a pH of 5.0 to 6.0. This reaction is almost instantaneous and in the time which elapses before application of lime a floc is partially formed. No value attaches to this floc formation, however, as lime dosage may be applied immediately following ionization of the chemical with equally good results. Since addition of hydroxyl ions tends to stabilize negatively charged colloids, therefore, hydroxyl alkalinity can not be applied prior to the coagulant dosage, otherwise color removal will prove difficult if not impossible.

Treatment as now practiced possesses advantages from the operation standpoint which are reflected in the results produced. Lime treatment to a high pH produces the true hydrous ferric oxide floc, which is dense, quick settling, stable, and not easily destroyed. The first two properties are directly reflected in the clarification of treated water during the sedimentation period and in increased length of filter runs. The third property means freedom from trouble in the basins, or filters, due to breaking down of floc. All four properties indicate a minimum of trouble from excessive currents in sedimentation basins.

In contrast to this, the "color floc" which is produced from ferric ion when coagulated at low pH is delicate and easily peptized. Maximum color removal is generally credited to this slightly acid zone (pH below 7.0). However, one instance is recorded (Wilmington, Calif.) in which a pure hydrous ferric oxide sludge was reused many times without impairment of its powers of adsorption for color. Colors up to 75 have been removed in plant practice at Providence and higher colors have been satisfactorily cared for on a smaller scale.

Iron removal from surface waters is most easily and completely accomplished by treatment at a high pH. Manganese may be economically removed on a large scale only at high pH. As will be noted from Fig. 2, manganese is completely removed and iron content of the effluent approaches complete absence at all times. Fig. 3 indicates the non-corrosiveness of the effluent when using this treatment. The figure shows the average amount of iron dissolved by Providence water between the purification plant and city taps when treated to various hydrogen-ion concentrations. Stability of the effluent is indicated by the fact that pH, alkalinity, color, hardness show no change during distribution and by absence of formation of deposits (manganese and organic matter) in the distribution system.

The above results have been accomplished with only a very moderate increase in hardness of the water and without other undesirable results.

Table II shows comparative data for six-month periods in three successive years. Method of plant operation was the same in each case. In the first period coagulant used was Ferrous Sulphate (Copperas), the second Chlorinated-Copperas, and the third Ferric Sulphate (Ferrisul). These data together with curves on Fig. 2 indicate that better results have been obtained with Ferrisul than with Chlorinated-Copperas, while requiring only 87 percent as much effective iron. There is no clear proof as to what proportion of this difference is caused by the presence of sulphate anions alone instead of 33 percent cloride and 67 percent sulphate anions, as in the case of Chlorinated-Copperas, or by our inability to feed chlorine and copperas always in correct proportions, thereby allowing passage of minute quantities of ferrous iron. Chemical costs have averaged the same amount less than was the iron consumption under that when using chlorine and copperas.

TABLE II
COMPARATIVE DATA FOR SIX-MONTH PERIODS, SEPTEMBER-FEBRUARY*

| | 1931-2 | 1932-3 | 1933-4 |
|---|---|---|---|
| Coagulant | Copperas | Chlorinated-Copperas | Ferrisul |
| Alkali | Hydrated lime | Hydrated lime | Hydrated lime |
| Iron required in coagulant dosage—Fe (p.p.m.) | 3.34 | 2.55 | 2.21 |
| Required-percent of previous | .... | 76% | 87% |
| Filter runs—average hours | 29.75 | 57.98 | 78.40 |
| Wash water—Percent of total filtered | 2.45% | 1.65% | 1.32% |
| Plant Effluent—Color | 12 | 10 | 8 |
| Iron Content (p.p.m.) | 0.16 | 0.07 | 0.04 |
| Hardness (p.p.m.) | 37.5 | 28.2 | 27.5 |
| pH | 9.8 | 9.7 | 9.8 |

*Note: This article was prepared for publication in March, 1934, which accounts for the period covered. The authors advise, however, that there has been no changes since to justify corrections or additions.—Editor.

# PASADENA'S NEW DAM DEDICATED: THE MORRIS DAM

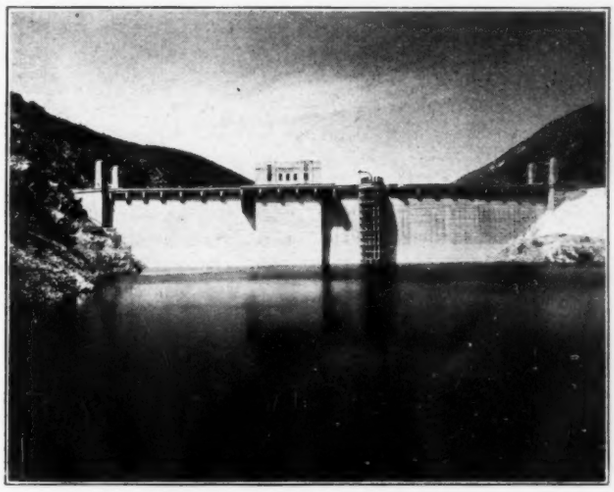
## Samuel B. Morris Honored, as Chief Engineer of the Project, by Change in Name of the Dam Which Was Dedicated by Ex-President Hoover.

THE Morris Dam, 4 miles above Azusa in San Gabriel Canyon, has just been completed by the city of Pasadena as the principal construction unit of its new $7,500,000 San Gabriel Water Project on May 26th. Ex-President, Herbert Hoover, dedicated the dam in honor of Samuel B. Morris, Chief Engineer and General Manager of the Pasadena Water Department, who conceived and constructed the project.

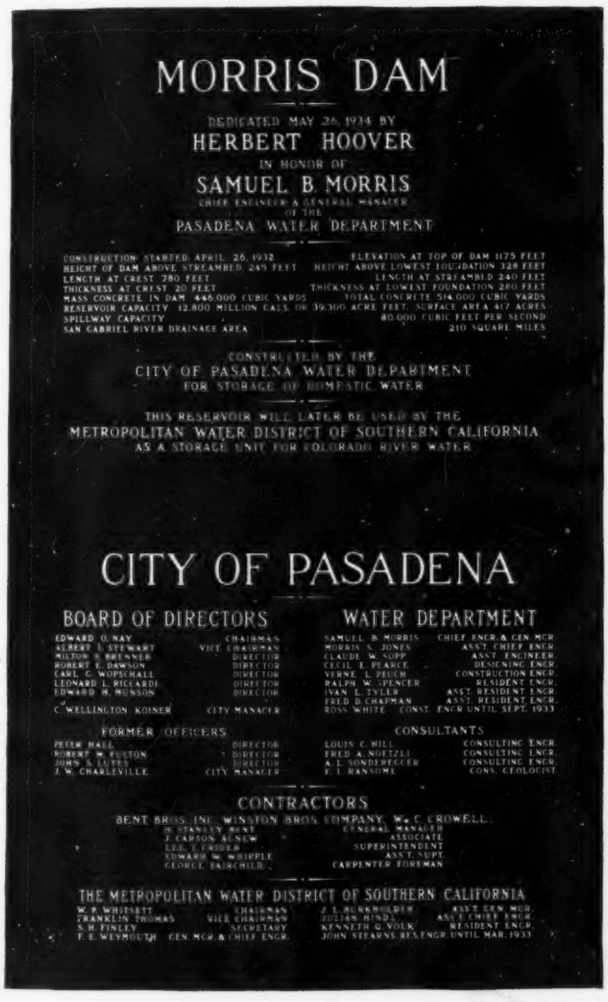
These works first planned over eleven years ago will enable the city of Pasadena to double its present population with security as far as water problems are concerned.

The Morris dam (cover illustration) is a concrete gravity dam rising 328 feet above its lowest foundations and intersecting 210 square miles of high mountain drainage. It creates a lake 3.5 miles long with maximum depth of 240 feet and capacity of 39,300 acre-feet or 12,800,000,000 gallons. The dam is 20 feet thick at its crest and 280 feet thick at its base. It is 780 feet long at its crest and 240 feet at streambed. The dam and appurtenances contain 514,000 cubic yards of concrete.

A spillway constructed over the west abutment spur has a maximum capacity of 80,000 cubic feet per second, which is double the maximum recorded flood discharge. There are six flood release outlets in the dam having a maximum release capacity of 7,000 cubic feet per second.



*Morris Dam: View from Up-Stream Shows Caterpillar Gate-House, Domestic Outlet Tower and Spillway on Right. Water Depth Which Is Here* 140 *Ft. Will Rise an Additional* 100 *Ft.*



MORRIS DAM

DEDICATED MAY 26, 1934 BY
HERBERT HOOVER
IN HONOR OF
SAMUEL B. MORRIS
CHIEF ENGINEER & GENERAL MANAGER
OF THE
PASADENA WATER DEPARTMENT

CONSTRUCTION STARTED APRIL 26, 1932
HEIGHT OF DAM ABOVE STREAMBED 245 FEET
LENGTH AT CREST 780 FEET
THICKNESS AT CREST 20 FEET
MASS CONCRETE IN DAM 446,000 CUBIC YARDS
RESERVOIR CAPACITY 12,800 MILLION CALS. OR 39,300 ACRE FEET
SPILLWAY CAPACITY
SAN GABRIEL RIVER DRAINAGE AREA
ELEVATION AT TOP OF DAM 1175 FEET
HEIGHT ABOVE LOWEST FOUNDATION 328 FEET
LENGTH AT STREAMBED 240 FEET
THICKNESS AT LOWEST FOUNDATION 280 FEET
TOTAL CONCRETE 514,000 CUBIC YARDS
SURFACE AREA 1417 ACRES
80,000 CUBIC FEET PER SECOND
210 SQUARE MILES

CONSTRUCTED BY THE
CITY OF PASADENA WATER DEPARTMENT
FOR STORAGE OF DOMESTIC WATER

THIS RESERVOIR WILL LATER BE USED BY THE
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
AS A STORAGE UNIT FOR COLORADO RIVER WATER

CITY OF PASADENA

BOARD OF DIRECTORS

| | |
|---|---|
| EDWARD O. NAY | CHAIRMAN |
| ALBERT L. STEWART | VICE CHAIRMAN |
| MILTON S. BRENNER | DIRECTOR |
| ROBERT E. DAWSON | DIRECTOR |
| CARL C. WOPSCHALL | DIRECTOR |
| LEONARD L. PICCARDI | DIRECTOR |
| EDWARD H. MUNSON | DIRECTOR |
| C. WELLINGTON KOINER | CITY MANAGER |

FORMER OFFICERS

| | |
|---|---|
| PETER MAIL | DIRECTOR |
| ROBERT P. PERRY | DIRECTOR |
| JOHN S. LUPTON | DIRECTOR |
| J. W. CHARLEVILLE | CITY MANAGER |

WATER DEPARTMENT

| | |
|---|---|
| SAMUEL B. MORRIS | CHIEF ENGR. & GEN. MGR. |
| MORRIS S. JONES | ASST. CHIEF ENGR. |
| CLAUDE W. SOPP | ASST. ENGINEER |
| CECIL E. PEARCE | DESIGNING ENGR. |
| VERNE L. PEUCH | CONSTRUCTION ENGR. |
| RALPH W. SPENCER | RESIDENT ENGR. |
| IVAN L. TYLER | ASST. RESIDENT ENGR. |
| FRED D. CHAPMAN | ASST. RESIDENT ENGR. |
| ROSS WHITE | CONST. ENGR. UNTIL SEPT. 1933 |

CONSULTANTS

| | |
|---|---|
| LOUIS C. HILL | CONSULTING ENGR. |
| FRED A. NOETZLI | CONSULTING ENGR. |
| A. E. SONDEREGGER | CONSULTING ENGR. |
| F. L. RANSOME | CONS. GEOLOGIST |

CONTRACTORS

BENT BROS. INC. WINSTON BROS. COMPANY, W. C. CROWELL.

| | |
|---|---|
| H. STANLEY BENT | GENERAL MANAGER |
| J. CARSON BENCH | ASSOCIATE |
| LEE E. CRIDLER | SUPERINTENDENT |
| EDWARD W. WHIPPLE | ASST. SUPT. |
| GEORGE FAIRCHILD | CARPENTER FOREMAN |

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

| | | | |
|---|---|---|---|
| W. P. WHITSETT | CHAIRMAN | J. L. BURKHOLDER | ASST. GEN. MGR. |
| FRANKLIN THOMAS | VICE CHAIRMAN | JULIAN HINDS | ASST. CONSULTING ENGR. |
| S. H. FINLEY | SECRETARY | KENNETH G. VOLK | RESIDENT ENGR. |
| F. E. WEYMOUTH | GEN. MGR. & CHIEF ENGR. | JOHN STEARNS, RES. ENGR. UNTIL MAR. 1933 | |

*Two Bronze Plaques Placed on Dam at Its Dedication*

The project will be operated in accordance with permits issued to the city of Pasadena by the State Division of Water Resources after a five year intensive hydrographic study of the San Gabriel River and the ground water basins affected by its flood run-off. These permits provide in brief that Pasadena will divert only flood water which would under natural conditions waste to the sea. The quantity of water which would have percolated into the ground is then released from the dam in a regulated continuous stream until the ground water basins receive their full natural benefit of percolation water.

The water salvaged from flood waste by the Morris Dam will average 15,600,000 gallons per day. This water will be conveyed to Pasadena by a 36-inch all welded steel pipe line 18.5 miles in length, terminating in distribution reservoirs along Mountain Street in Pasadena.

*Ex-President Hoover Delivering the Dedication Speech: "I Dedicate the Morris Dam to the Service of a Hundred Generations of Americans"*

The general contractors for the Morris Dam were Bent

Brothers, Inc., Winston Bros. Company and William C. Crowell. Mr. Morris is Chief Engineer and General Manager of the Pasadena Water Department, Verne L. Peugh and Ross White served as Construction Engineers, and C. E. Pearce as Designing Engineer on the project.

These works first planned over eleven years ago will enable the city of Pasadena to double its present population with security as far as water supply problems are concerned.

In his speech of dedication, ex-President Herbert Hoover said:

"I have followed this great work for some years, both as one interested in public affairs and an engineer.

"As an engineer I take especial pride in the exhaustive planning and investigation, the scrupulous construction of its engineer leader, Samuel B. Morris. The project presented technical problems and difficulties, which he and his assistants have successfully solved, and through the cooperation of Bent Brothers, Inc., Winston Brothers, Inc., and William C. Crowell, the contractors, they have procured a structure which will be standing a thousand years hence.

"But this dam is much more than a mere material achievement; it stands as another monument to the practical efficiency of intelligently organized community purpose—the supreme impulse to constructive progress in this state and nation.

"Behind these ceremonies today lie weeks and months of skillful planning and patient organization—and several years of old-fashioned struggle and hard work. . . . Ahead lie years of beneficent service to this community, and this is the decisive test of truly constructive enterprise.

"I congratulate your engineers and builders upon their professional accomplishment; I congratulate this community upon its laudable demonstration of constructive achievement.

"On behalf of those far-seeing leaders of this community, the engineers whose skill has brought this plan to practical realization, and the community which has given to them their loyal support, I dedicate the Morris Dam to the service of a hundred generations of Americans who will receive the blessings."

Following the dedication exercises a banquet was given in Mr. Morris' honor. At this Mr. Hoover was the principal speaker.

▼

## P.W.A. Appoints Special Engineering Board for Twin-Cities Sewage Works

To end local controversies and force immediate construction of the $18,000,000 St. Paul-Minneapolis sewage works, Public Works Administrator Harold L. Ickes exercised the Government's right to supervise the project.

Ordering construction, which may be started, to be put under way at once, Administrator Ickes named a special engineering board to examine various phases of the project and supervise the plans so that a sound, economical sewage plant may be pushed toward completion. The board will be responsible for engineering and design subject to approval of the Administrator.

Many technical decisions must be made by this board on the type of construction employed and the size of the facilities installed. To this end the board is authorized to retain sewerage and sewage treatment experts as advisers and consultants.

More than a million dollars' worth of construction may be advertised and started promptly and this project will be the largest construction job ever undertaken in St. Paul and Minneapolis.

The following constitute the board named:

Frederick Bass, Dean of Engineering at the University of Minnesota.

Brig.-Gen. Charles W. Kutz (retired), U. S. Army Engineering Corps, Chairman.

Wm. N. Carey, State Engineer of PWA for Minnesota.

▼

## In Peace Prepare for War

The New York State Department of Health in revealing the findings of its survey, covering 307 municipalities, to show the extent of monetary damages and hazard to life and property caused by frozen water mains and service pipes, preaches the doctrine of being prepared before another winter arrives.

In 181 New York municipalities there were reported 10,000 frozen services; 147 had frozen mains and one city had 50 broken mains. The cost of thawing operations was $125,000, with rental on thawing equipment varying from $2.50 to $15 per hour, when available.

Electrical thawing in 143 municipalities proved the most efficient method employed and was satisfactory except for the high rentals charged by owners of thawing equipment who supplied machines and service. The electrical method proved satisfactory in direct proportion to the size (capacity) of machines employed. The largest machines were capable of thawing mains with lead substitute joints and copper service lines without the difficulty which was experienced with the small capacity machines. Services of electrical experts, while helpful, were not found to be necessary when instructions put out by thawing machine manufacturers were intelligently followed.

Charges of $5 to $10 (the former prevailing) were made against consumers for each service thawing operation. Roughly, 48 per cent of the municipalities charged the full fee; 27 per cent bore half the fee charged, and the remainder (25 per cent) stood all costs of the service.

The report of the New York State Department of Health—Division of Sanitation—will prove highly beneficial to heads of water departments and constitutes a worthy service performed. It will be reproduced in a fall issue of WATER WORKS AND SEWERAGE, as will other material pertaining to winter operation and maintenance of water works systems, which has come out of 1934 experiences with cold weather troubles.

▼

### Milwaukee Sewage Treatment Plant to Be Enlarged

Milwaukee will spend $2,500,000 for extending its sewage treatment facilities at the Jones Island Treatment Works.

The extended plant will have a normal capacity of 155 M.G.D., which is almost double that of the existing plant—85 M.G.D. Major units consist of 6 new sedimentation tanks and 12 aeration tanks. The sludge collecting equipment will be that invented by D. W. Townsend and Joseph Brower, known as the "Tow-Bro" Collector, which operates withdraw sludge from all sections of the tank bottom through revolving pipe arms with suction nozzles spaced along the arms.

Contracts for diffuser plates have gone to the Carborundum Company of Niagara Falls and the Norton Company of Worcester, Mass., and for sludge removal mechanisms to the Chain Belt Company of Milwaukee.

# GEORGE W. FULLER

GEORGE W. FULLER, sanitary engineer and internationally-known expert on water supply and sewerage, died on June 15th, after a brief illness at his residence, 30 Fifth Avenue, New York City. He was 65 years old, had for many years been engaged in consulting practice in New York City and was in recent years the senior member of the well known firm of Fuller and McClintock.*

Mr. Fuller, of English-Scotch ancestry, was born at Franklin, Mass., the son of George Newell Fuller and Harriet Craig Fuller, his paternal ancestors having settled in this country in 1642 established a homestead at Dedham, Mass.

In 1890 he was graduated by the Massachusetts Institute of Technology and thereafter studied for about a year at the University of Berlin and in the private office of Piefke, engineer of the Berlin Water Works.

## Pioneered in Sanitary Engineering

Returning to America he devoted about nine years to research work on methods of purifying water and sewage from the biological, chemical and engineering viewpoints.

He was with the Massachusetts State Board of Health for nearly five years, during the latter part of which he was in charge of the Lawrence Experiment Station and extended the work initiated by himself and another famous chemist and engineer, the late Allen Hazen. In 1895 he went to Louisville and for two years conducted experiments for the Louisville Water Company on the suitability of various processes of filtration which might prove adaptable in purifying turbid waters such as that of the Ohio River. The report of these studies and investigations became a classic and opened up a new era in water purification practice. His work demonstrated the ability of coagulation and rapid sand filtration (then termed mechanical filtration) to handle mud laden and highly variable waters. The developments at Louisville formed the basis of American water purification practice since that time. Particularly did these studies reveal the major importance of effective coagulation and sedimentation prior to filtration. Following the Louisville studies he had charge of similar researches at Cincinnati and then was called in, with Robert Spurr Weston, to advise the city of New Orleans on its purification problems. Coagulation prior to filtration became an established practice as the result of Mr. Fuller's work and he also proved the economy of the American (mechanical) system of filtration over the so-called English (slow-sand filtration) system then so much in vogue.

*Fuller as a Lad (7½ Years Old)*

A group of men who subsequently made names for themselves in the field of sanitation were associated with Mr. Fuller at Louisville. These were Robert Spurr Weston, Joseph W. Ellms, the late George A. Johnson and George A. Soper. Later, Ellms was retained by Cincinnati and Weston by New Orleans. Johnson, who was responsible for the first American installations for the chlorination of water, was at that time an associate with Mr. Fuller who was consultant on the projects.

*George W. Fuller, When President of the American Public Health Association in 1928*

Mr. Fuller established a consulting office in New York in 1899. In 1901 he went into partnership with the late Rudolph Hering under the firm name of Hering and Fuller. In 1911 he again began practicing under his own name and so continued until 1916 when he formed a partnership with the late James R. McClintock. The earliest Imhoff tank sewage treatment plants in America—those at Chatham, N. J. and Atlanta, Ga., were designed by Hering and Fuller in 1910 and 1911.

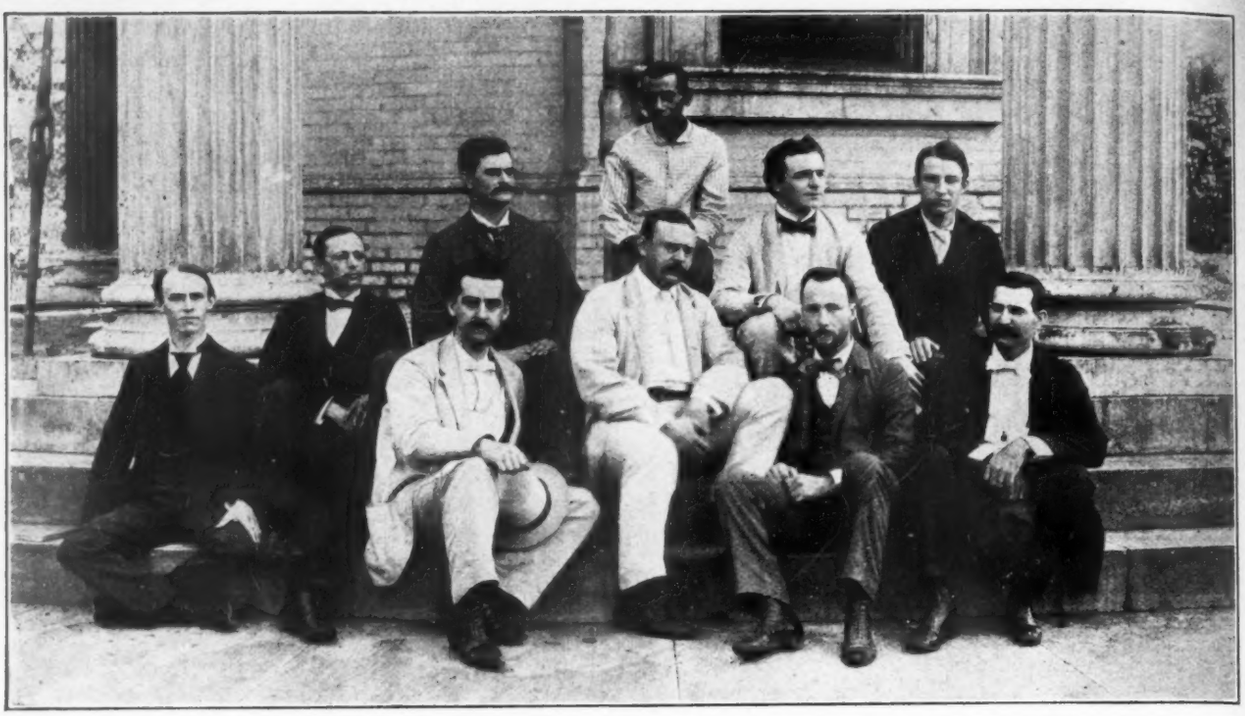
*Fuller at 21 Years of Age†*

During the World War Mr. Fuller was a member of a Central Committee at Washington having to do with the planning, engineering and sanitation of the various army camps and was also consulting engineer to the United States Public Health Service and the Construction Division of the U. S. Army.

One of the most important works performed by Mr. Fuller was accomplished in 1924 and 1925 for the Sanitary District of Chicago, when as chairman of a board of 28 experts he dealt with the problems involved in disposing of Chicago's sewage. He was recalled just

*The third member of the firm, since 1928 was F. G. Cunningham but the name was not changed, even upon the death of Mr. McClintock.

†The Upper Figure Is the Young Graduate of Massachusetts Institute of Technology While a Student in Berlin in 1890.



*Fuller and Staff at Louisville,* 1895-1896. *Upper Row (Left to Right): Robert Spurr Weston, Assistant Chief; William, the Janitor; George A. Johnson, Bacteriologist; Stevens, Assistant Engineer. Center, George W. Fuller, Chief. Lower Row (Left to Right): Bockenhouse, Assistant Engineer; J. W. Ellms, Assistant Chemist; Parmalee, Assistant Engineer; Hill and Benton, Assistant Bacteriologists.*

this year (1934) by the U. S. Government to advise a special Board of Review on the processes to be used in proposed additions to Chicago's system. He was also very recently selected to head a committee of engineers to determine the methods and structures to be employed by Minneapolis and St. Paul, Minn., in treatment of sewage from the Twin-Cities District.

Mr. Fuller served as a consultant on sewerage and sewage disposal for the Metropolitan Sewerage Commission of New York and in 1928 and 1929 he reported to the city of New York upon the Wards Island sewage treatment works, and his firm afterwards prepared the plans for this project which is now partially constructed. Since 1906 he had been consultant to the New York Board of Water Supply on various sanitation problems.

During his professional career Mr. Fuller served as consulting engineer for major water works and sewerage improvements in more than 150 large cities in this country and abroad and numerous smaller ones. Just prior to his death the firm completed a report on a future water supply for the Minneapolis-St. Paul Water District and another to the Metropolitan Sewerage Commission of Rhode Island, involving sewage disposal for Providence and 17 neighboring municipalities.

## Standardization His Hobby

Mr. Fuller took a keen interest in activities aimed towards the standardization of practices and contributed largely to the development and widespread adoption of the Standard Methods of Analysis for Water and Sewage sponsored by the American Public Health Association. More than any other individual he, as Chairman of the Council on Standardization of the American Water Works Association, was responsible for the successful publication of the Manual of Water Works Practice by that association in 1925. In other directions Mr. Fuller gave liberally of his time and efforts to better association activities. Serving as a masterful chairman of numerous committees he harmonized and spurred on the work in hand. As an organizer and coordinator he did a splendid piece of work for the American Public Health Association as its president in 1928.

Mr. Fuller was a past president of the American Water Works Association and of the American Public Health Association, and past vice president of the American Society of Civil Engineers, and a member of numerous other professional, scientific or honorary societies. He was elected chairman of The Engineering Foundation in 1933 and held that office at the time of his death. He was author of numerous important professional papers and three books.

Mr. Fullers' body lies buried in his native New England soil at West Medway, Mass., but the memory of his abilities as an engineer, organizer and leader; his kindliness and helpfulness as an adviser, will long remain with those who knew him.

▼

## Improved Indicator for Alkalinity Determination

In determining the alkalinity of a water, when using methyl orange as the indicator, the end point is not always sharp and results in some difficulty in seeing the change at the end point. To overcome this, a method has been developed by August G. Nolte, former Chief Chemical Engineer, Chain of Rocks Filtration Plant, St. Louis. It is now being used at several points.

Xylene Cyanole produces a bright blue color when dissolved in water, and this color is not affected by slight excess of acid or alkali. The blue color accentuates the color change of the methyl orange and makes the end point easily seen. The amount of methyl orange is 1.5 grams and the xylene cyanole 0.34 gram, both being dissolved in the same 1000 milliliters of water. One drop of the indicator is used for 100 milliliters of sample being titrated. The color change from alkaline to acidic is marked.

# HOURLY LOAD VARIATIONS AS A FACTOR IN SEWAGE TREATMENT PLANT OPERATION

By ELSON T. KILLAM

*Associate Alexander Potter, Consulting Engineer, New York City*

*E. T. Killam*

THE combined effect of the substantial variations which normally occur both in the rate of flow and in the concentration of sewage arriving at a treatment plant at different hours of the day, is a controlling factor in the efficiency of plant operation, and at plants which permit of flexibility of operation, load variation is of great importance in its effect on cost of operation.

These variations are normally so great that samples of plant influent and effluent, and samples of receiving streams are seldom comparable or even truly representative of actual plant efficiencies, or of actual stream conditions, unless such samples are carefully collected throughout a full 24-hour period.

It has been found that even in a large system in which the variations are comparatively small in proportion, that the load, based on suspended solids and flow variations for a 2-hour period, was 14 times the load in the minimum 2-hour period, and that based on variations in flow and B.O.D. the ratio was 44 to 1, for maximum and minimum 2-hour periods respectively.

In a comparatively small system in which the variations were relatively marked, it was found that the load in the maximum 2-hour period was 1,800 times the load in the minimum 2-hour period, based on suspended solids and flow variations.

There can be no stronger evidence of the desirability of providing for flexibility in the design of sewage treatment plants, than is demonstrated by such substantial variations in load, particularly when variations in the load which can be absorbed by the receiving stream, are also considered.

As is the case with other considerations in sewage treatment, ordinarily necessitating particular investigation for each municipality or plant, the magnitude and relative time interval of such variations will vary considerably at different plants.

Among the more important factors influencing the relative load curves in each specific case, are the following:

(a) The mileage involved in the collecting system, and the relative sewer grades—both of which control the average time required for sewage to reach the plant.

(b) The relative amount of infiltration—which substantially affects the ratio of maximum and minimum flow to the average rate of flow, and which also particularly affects the quality of the sewage in the early morning hours.

(c) The habits of the contributing population with regard to hours of rising and retiring.

(d) The prevalence of industries contributing industrial waste, and their practice as regards hours of operation.

It is obvious that at the terminus of an extensive system of sewers with relatively flat grades, with high infiltration and with industries operating on a 24-hour basis, that the variations in rate of flow and quality of sewage will be somewhat smoothed out, and will be much less pronounced than load variations in a small system serving a strictly residential area.

Nevertheless, detailed investigation of load variations in a substantial number of systems involving radically different conditions, indicates a general occurrence of such variations together with a surprisingly uniform trend of load curves in all cases. (See Plate III.)

While the collection and analysis of hourly samples of plant influent and effluent throughout a full 24-hour period, necessarily involves a considerable amount of work, it is the opinion of the writer that where facilities make such a test possible, the value of the results makes such an investigation well worth while. It is further believed that in many instances, more data of direct

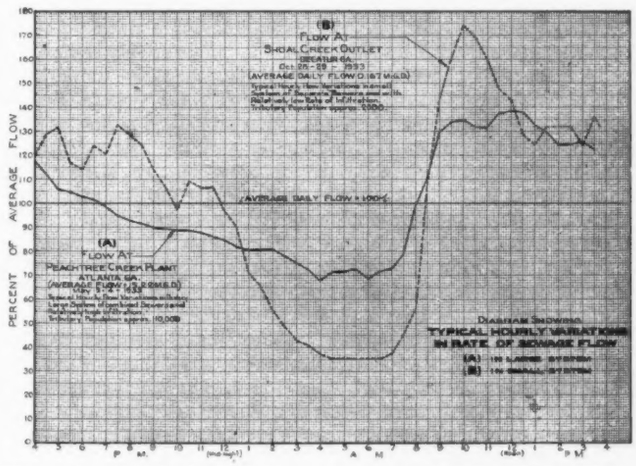



*Plate I.—Hourly Variations in Rates of Sewage Flow—Comparing Large with Small Systems*

benefit to efficient and economical plant operation will be obtained by a test of this nature, than by the study of many weeks of plant performance records based only on results of 24-hour composite samples.

A study of plant performance under the widely varying conditions normally occurring during a 24-hour period, and an investigation of the efficiency of the plant under the varying loads normally developed, provides a valuable basis for analysis of a variety of angles of plant operation. Such data is of particular value in planning alterations or supplementary treatment for overloaded plants.

## Variations in Rate of Flow

Typical hourly variations in rate of sewage flow are illustrated on Plate I. Curve A is representative of the normal variations of flow in an extensive collecting system of large combined sewers with a relatively high rate of infiltration. In this system the maximum hourly rate

was 138 per cent and the minimum 70 per cent of the daily average rate of flow.

Curve B is typical of flow variations in a relatively small separate system serving a strictly residential community, and with a low rate of infiltration. In this case it will be noted that the variations in rate of flow are of considerably greater magnitude than in the system illustrated by Curve A. The maximum hourly rate of

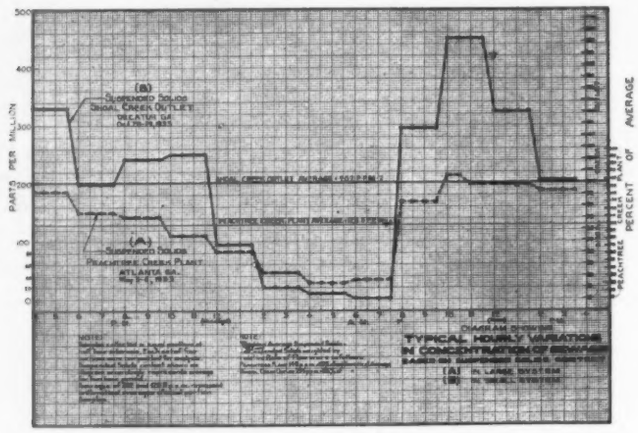



*Plate II.—Hourly Variations in Strength of Sewage—Based on Suspended Solids Concentrations in Sewages from Large and Small Systems*

flow was found to be 165 per cent, and the minimum 35 per cent of the daily average flow.

## Variations in Sewage Concentration Based on Suspended Solids Content

Typical hourly variations in suspended solids content of the sewage in the same two systems as discussed under the previous heading, are illustrated on Plate II. As in Plate I, Curve A represents the variations in the larger system, and Curve B the variations in the smaller system. It will also be noted that variations in suspended solids as well as in rate of flow, are much less marked in the larger Peachtree Creek system than in the relatively small Shoal Creek system.

In the Peachtree Creek system, the maximum concentration of suspended solids for a 2-hour period, was equal to 167 per cent of the arithmetical daily average, and the minimum concentration for a 2-hour period was equivalent to 22 per cent of the daily average. In the Shoal Creek system, the maximum concentration of suspended solids for a 2-hour period was 223 per cent, and the minimum only 0.5 per cent of the arithmetical average suspended solids content for the day.

The suspended solids content from 10 a. m. to 12 noon, which occurred coincidentally with the highest rate of flow for the day, was 450 p.p.m.; whereas in the early morning hours the suspended solids content dropped to the extraordinarily low value of 1 p.p.m.—a concentration which was accompanied by the minmum rate of flow for the day. This latter value is obviously so low as to be of questionable accuracy. However, this result was obtained by evaporation of five times the portion of sewage ordinarily utilized for this determination.

The wide variations in concentration are further illustrated by the photograph designated Plate IV. Each bottle represents a composite of four equal-portion half-hourly samples, or in other words, is practically representative of the average strength for a 2-hour interval. The set of 12 bottles shown, accordingly covers a complete 24-hour period.

The period covered by each of the 12 samples in reference to the hour of the day and the suspended solids content during each 2-hour period, are shown in the tabulation appearing under the photograph.

## Hourly Variations in Load

The hourly variations in load resulting from the combined effect of the above described changes in both rate of flow and in suspended solids concentration, are obviously very appreciable in magnitude.

In the Peachtree system, the load in the 2-hour period of maximum concentration, was 190 per cent, and in the minimum was 14 per cent of the average daily load. In the Decatur-Shoal Creek system, the ratio of maximum and minimum 2-hour load periods, was respectively 280 per cent and 0.16 per cent of the average daily load.

In the investigation at the Peachtree Creek plant, it was also found that the trend of B.O.D. content throughout the day, was quite similar to the variations in suspended solids content, this similarity being apparent by comparison of curves A and D on Plate III.

## Variations in Dissolved Oxygen and Turbidity

In addition to hourly variations in flow, suspended solids and B.O.D., similar variations in turbidity occur, and in many systems, the sewage contains a substantial amount of dissolved oxygen in the hours of light load. This dissolved oxygen is a substantial factor in improving conditions within the treatment plant units.

Typical variations in dissolved oxygen content and the inverse relation to turbidity, are illustrated on Plates V and VI.

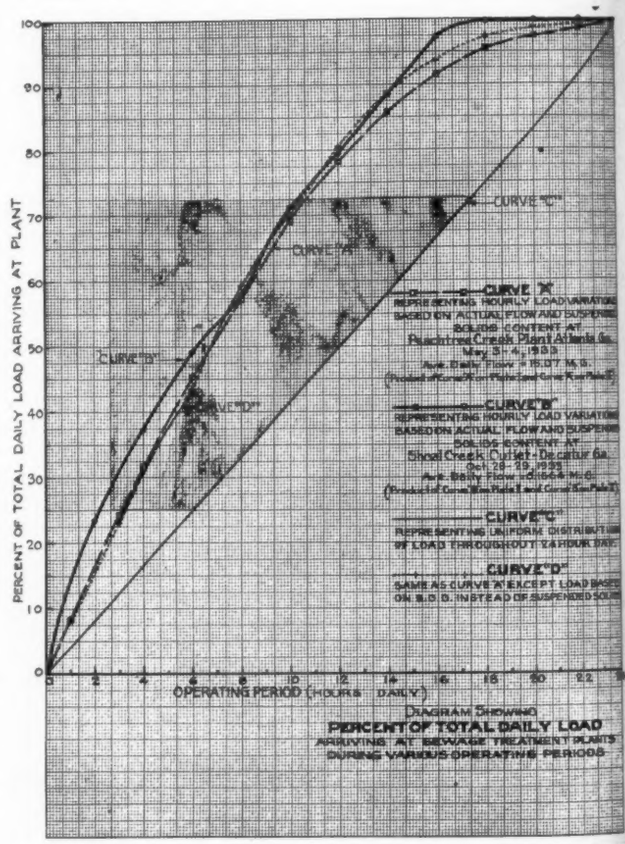



*Plate III.—Portions of Total Daily Sewage Load Reaching Treatment Plant or Stream During Various Periods of a Given Day—For Large and Small Systems*

## Cumulative Load Curve

Cumulative load curves plotted on Plate III, are based on the hourly changes in load shown on Plates I and II. Curve A on Plate III represents the combined effect of changes in rate of flow and suspended solids in the Peachtree Creek system, and Curve B the

combined effect of these two factors on the Decatur-Shoal Creek system.

Curve C (Plate III) drawn only as a base for comparison, shows the cumulative load assuming a uniform distribution of load throughout a 24-hour period.

Curve D (Plate III) is also based upon the Peachtree Creek plant, but it represents the combined effect of changes in rate of flow and 10-day B.O.D., instead of variations in flow and suspended solids.

In these load curves, the curve starts with the 2-hour period of greatest load, and the load for each additional consecutive 2-hour period was selected in order of decreasing magnitude, thereby developing a cumulative total as shown by these curves.

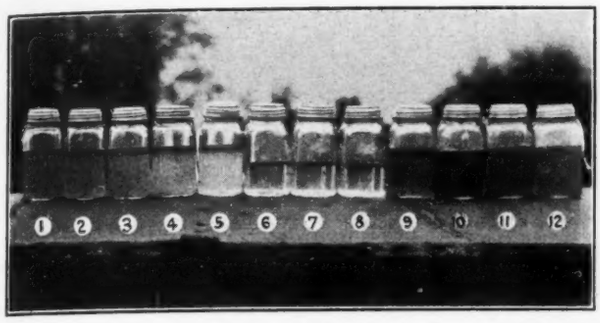


*Plate IV.—Samples of Sewage Which Illustrate Variations in Strength of Sewage During 2-Hour Periods Throughout the Day*

*(Sampled at Shoal Creek Sewer Outlet, Decatur, Ga., Oct. 28 and 29, 1933)*

| Sample | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P.M. | P.M. | P.M. | P.M. | Mid. | A.M. | A.M. | A.M. | A.M. | A.M. | Noon | P.M. |
| Sample Period | 4 to 5:30 | 6 to 7:30 | 8 to 9:30 | 10 to 11:30 | 12 1:30 | 2 to 3:30 | 4 to 5:30 | 6 to 7:30 | 8 to 9:30 | 10 to 11:30 | 12 1:30 | 2 to 3:30 |
| Suspended Solids ppm... | 330 | 200 | 245 | 250 | 95 | 20 | 10 | 1 | 295 | 450 | 325 | 205 |

Arithmetical Average ..... 202 ppm
Weighted Average (by Flow)..... 254 ppm

Each sample consists of four equal portions collected at half-hour intervals.

By inspection of these curves, it will be seen that a high percentage of the total daily load arrives at the plant in a comparatively short interval, as indicated by the following summary table.

| Hours of Operation | Percentage of Total Daily Load |
|---|---|
| 6 hours ..... | 45 |
| 8 hours or 1 shift..... | 60 |
| 12 hours ..... | 80 |
| 16 hours or 2 shifts..... | 95 |

This concentration of the major portion of the daily load into a relatively short period, is important in affecting the efficiency and cost of operation of sewage treatment plants, from the following viewpoints:

(1) The relatively limited period comprising the period of maximum concentration, is a controlling factor in fixing design capacities.

(2) The period of extremely light load, particularly in respect to B.O.D., obviously affords a breathing spell or rest period which in many cases is beneficial to the operation of activated sludge and trickling filter plants.

(3) Where flexibility is provided in the design of a plant, changes in operating procedure can be made in different periods throughout the day, particularly with regard to the number of units in service, degree of treatment, etc.

(4) The basic advantages of providing a supplementary treatment to assist in the efficient handling of peak loads, and the possible economies to be gained in both construction and operation cost by so doing, are clearly indicated.

(5) With chemical type treatment plants, the feasibility of providing attendants during two shifts only, or in certain seasons for even shorter periods of operation, is clearly indicated.

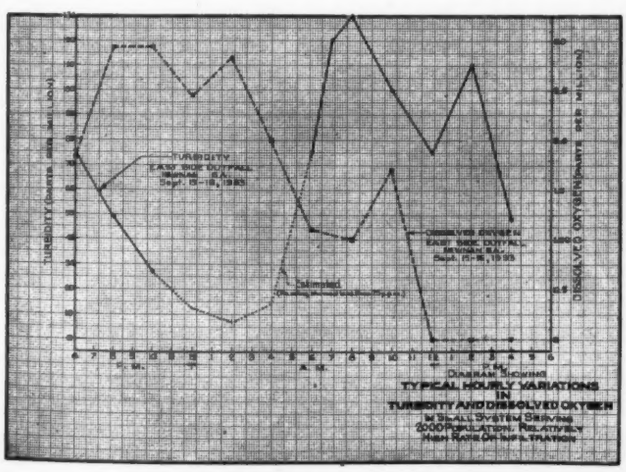
(6) The general occurrence of substantial load variations clearly indicates the fact that no accurate estimate of plant performance can be arrived at unless the samples taken to determine plant efficiency adequately cover a full 24-hour period.

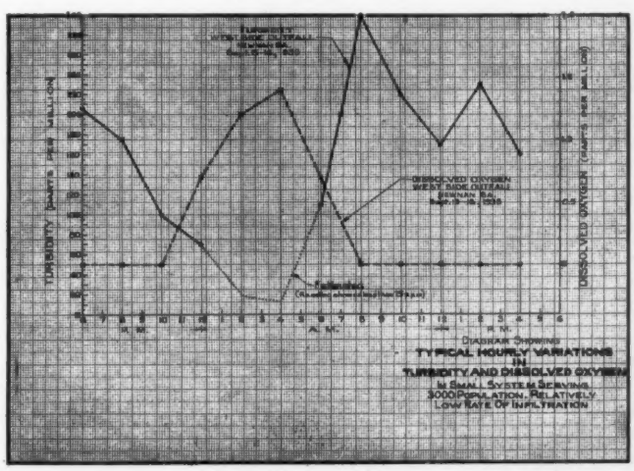
(7) Substantial changes in load entering the plant are inevitably reflected in the effluent. Accordingly, the hour of the day and the distance below the plant outlet, will have an appreciable effect upon apparent results when sampling and analyzing samples from receiving streams. Where samples are taken from receiving streams below direct sewer outlets, in the absence of treatment plants, it is obvious that this effect will be far more noticeable.

(8) In the operation of test plants of any type, 24-hour operation is essential in order to obtain a proper record of plant efficiency. With test plants on chemical treatment, neither efficiency nor cost of operation, nor a comparison of the results of one plant with another, can be properly ascertained unless 24-hour operation has been adopted.

## Similarity of Load Curves on Plate III

The load curves shown on Plate III, designated A, B and D, show a remarkable similarity when it is considered that Curve A is based upon flow and suspended solids variations in an extensive system of sewers with a total flow of 15 M.G.D.; whereas Curve B based also




*Plates V and VI.—Hourly Variations in Turbidity and Dissolved Oxygen Content of Sewage in Small Community—High Rate of Infiltration vs. Low Rate of Infiltration*

on variations in suspended solids and flow, represents results in a system of a radically different character, and with a total flow of approximately but 1 per cent of the flow involved in Curve A—namely, 0.167 M.G.D. It would be normally expected that in two systems having a 100 to 1 total daily flow ratio, a substantial variation would be found in the resulting load curves, but this is not the case.

It will be also noted on Plate III that Curves A and D are for the same system, namely, the Peachtree Greek system, but Curve A is based upon the combined effect of flow and suspended solids; whereas Curve D is based upon the combined effect of flow and 10-day B.O.D.

## Feasibility of Part Time Operation Due to Concentration of Load

Under many conditions it will be found that where load variations similar to those shown on Plate III occur,

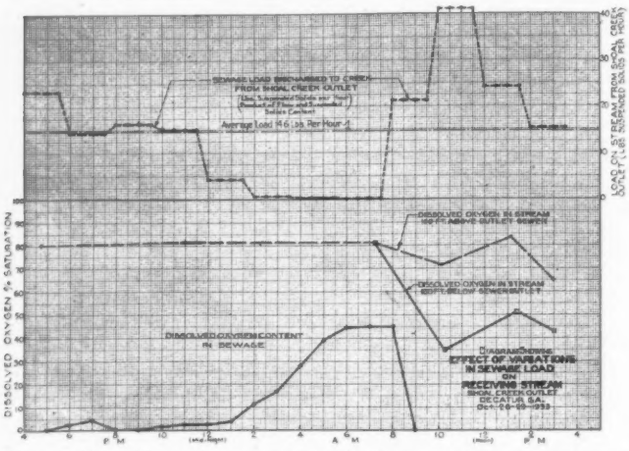

SEWAGE LOAD DISCHARGED TO CREEK FROM SHOAL CREEK OUTLET
Average Load 46 Lbs Per Hour
DISSOLVED OXYGEN IN STREAM 100 FT ABOVE OUTLET SEWER
DISSOLVED OXYGEN IN STREAM 100 FT BELOW SEWER OUTLET
DISSOLVED OXYGEN CONTENT IN SEWAGE
EFFECT OF VARIATIONS IN SEWAGE LOAD ON RECEIVING STREAM
SHOAL CREEK OUTLET
DECATUR, GA.
DISSOLVED OXYGEN % SATURATION
P. M.
A. M.

*Plate VII.—Effects of Hourly Variations in Sewage Load on a Receiving Stream*

that part time operation, particularly with chemical treatment, is feasible and advantageous.

A substantial item of cost, especially in relatively small sewage treatment plants, is the cost of providing attendants during three-shift operation. In cases where approximately 95 per cent of the total daily load arrives at the plant in 16 hours, it is obviously entirely practical to provide attendants only during this period, and to allow the light load in the early morning hours to pass through the clarifier without attendance. In other words, if 95 per cent of the load is given the desired degree of treatment, the efficiency with which the remaining 5 per cent is treated, is of little importance.

The sewage in the early morning hours, in many instances, is relatively free from B.O.D. in the supernatant fractions of the sewage and in most instances dissolved oxygen is present in the sewage at such times. Due to the favorable character of the sewage in this period, and the low rate of flow with the consequent long detention period afforded, plain sedimentation will frequently provide an entirely adequate treatment.

In many instances, particularly during periods of high stream flow, operation for 12 hours or even less (during the period of high concentration) may be all that circumstances demand.

## Effect of Load Variations on Receiving Stream

The effect of the above described variations in load on the quality of the receiving stream, is often very noticeable. This was particularly true in the Decatur-Shoal Creek investigation, which is illustrated by Plate VII.

Throughout the evening hours, only a trace of dissolved oxygen was present. Beginning at 1 a. m. the content substantially increased, reaching a maximum of 45 per cent of saturation from 7 to 8 a. m., but the dissolved oxygen content immediately vanished when the highly concentrated sewage began to arrive shortly after 8 a. m.

Samples of stream water tested for dissolved oxygen, taken above and below the outlet, showed 81 per cent saturation at both stations at 7:30 in the morning. At 10 o'clock, after the stream had been subjected to the high flow of concentrated sewage, arriving between 8 to 10 a. m., the stream above the outlet showed a saturation of 72 per cent whereas the stream below the outlet dropped to a saturation of only 35 per cent.

Throughout the day the difference between the saturation at the upstream and downstream stations showed a direct response to the quality and quantity of the sewage discharged from the outlet.

## Conclusions

(1) It is evident that sewage treatment plants are called upon to do heavy duty during a portion of each 24-hour day and little or no work during the remaining hours.

(2) In biological plants the low loading periods allow the process to recuperate if overtaxed during the heavy duty periods and recurring period of light loading, therefore, essential for the well being of such processes.

(3) In many instances economy of performance might be had by patterning the operation of the plant to meet the schedule of loading requirements only. Such may entail design features making for greater flexibility of operation than have previously been provided.

(4) In chemical treatment processes the cost of treatment can be materially and logically decreased by modification or cessation of the use of chemicals, other than chlorine, during periods of light plant loading. Chlorination processes are already being successfully operated according to such a scheme, with economy resulting.

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## A. U. Sanderson Made Chief of Toronto Water Supply

*A. U. Sanderson*

A. U. Sanderson, formerly assistant engineer, has been made Engineer in Charge of Water Supply in the Toronto Department of Works, and L. F. Allen, Superintendent of Filtration, has been made Assistant Engineer of Water Supply. Mr. Sanderson has for some years been a director and active member in the American Water Works Association and particularly in the Canadian Section which he has served as Chairman just recently.

To you, "Sandy," we extend our congratulations and best wishes!

▼

SEWAGE PLANT OPERATIONS AT MILWAUKEE.—The following note is taken from the 1933 annual report of the Common Council in Milwaukee, Wis.:

During the past year, the disposal plant treated an average of 82.52 million gallons of sewage per day, removed 97.4 per cent of the bacteria, and 93 per cent of the suspended solids. It produced a total of 32,398 tons of Milorganite.

# TREATING WATER WITH THE AID OF MAGNESIUM METAL

By HERMANN BACH, Ph.D.

*Chief Chemist, Emschergenossenschaft,* Essen, Germany*

SINCE the time that chlorination developed into a standard method of securing the hygienic safety of drinking water, there has been a constant search for substances able to remove the superfluous part of the chlorine dose remaining in water after the germicidal action is completed. This in order to free the water of the strong taste and smell usually connected with a content of free chlorine. "Dechlorination" is in many cases a necessary subsequent treatment to the chlorination of water and is especially unavoidable if the water has been "superchlorinated" in order to destroy taste and smell producing organic substances in addition to bacteria.

Such materials as sulphurous acid, thiosulphate of sodium, activated carbon and other materials have been employed for dechlorination of water with varying degrees of success.

Some twenty years ago in the early history of water chlorination, when visiting the detinning plant of the well-known Th. Goldschmidt Chemical Works at Essen, in which chlorine is used to remove tin from galvanized sheet scraps, wasted cans, etc., I conceived the idea of removing chlorine from water by means of tin metal. Experiments were carried out in cooperation with the above named firm and led to some patents being granted. However, the process proved unreliable because the tin scraps employed in the dechlorination filters coated gradually with bichloride of tin, thus forming a protective film which prevented contact of the chlorinated water with the dechlorinating agent.

In the fall of 1931, while visiting the works of the Dow Chemical Co. in Midland, Mich., I was impressed by the outer appearance of the silver-like shining surfaces of Dow metal pieces, especially of scraps and turnings remaining as wastes from the manufacture of diverse articles. Dow metal consists essentially of magnesium alloyed with some small amounts of other metals.

After my return home I took up my old ideas as to the dechlorination of superchlorinated water by means of metal filters and resolved to try magnesium metal for this purpose. I am very indebted to the J. G. Farbenindustrie A.G. in Bitterfeld for loyal collaboration in this matter, also to the Dow Chemical Co. In addition to the opportunity given me to visit their splendid works, the latter furnished me with several samples of Dow metal turnings and similar material.

## The Reactions of Magnesium with Water and with Chlorine

Magnesium metal reacts with chlorine dissolved in water in two ways:

1) $Mg + 2Cl = MgCl_2$

This equation means that 24.32 parts (by weight) of magnesium combine with 70.914 parts of chlorine to form 95.23 parts of magnesium bichloride. Thus 1 kg. (2.2 pounds) magnesium metal should suffice to bind 2.916 kg. (6.4 pounds) of free chlorine if this reaction would proceed undisturbed. However, there occurs simultaneously a second reaction, namely

2) $Mg + 2Cl + 2H_2O = Mg(OCl)_2 + 2H_2$

thus forming magnesiumhypochlorite, a compound analogous to the well-known hypochlorite of lime. In the hypochlorite form the chlorine is only loosely bound because a very slight acidification caused (e.g., by the carbon dioxide content of the air) sets the chlorine free according to the formula

3) $Mg(OCl)_2 + 2CO_2 = Mg(CO_3)_2 + 2Cl$

Fortunately it has proved that the velocity of the first reaction is much greater than that of the second reaction. Therefore, if the chlorinated water is only a short time in contact with the magnesium metal the first reaction predominates and the bulk of free chlorine combines to produce bichloride of magnesium; while, only a small fraction of chlorine enters into the hypochlorite compound. Therefore, by proper regulation of the velocity of the chlorinated water in the filter filled with magnesium turnings (Fig. 1) it is easy to remove free chlorine from the water, leaving only a negligible trace of hypochlorite in it.

*Fig. 1—Magnesium Turnings Used in Dechlorination and Deacidification of Waters.*

The above concerns chemically pure magnesium metal. In practical cases one must deal with magnesium alloyed with small amounts of other metals and occasionally containing some substances which remain from the manufacturing process, and it is, therefore, very important to select a material especially fit for water treatment. The velocities of both reactions seem to be affected by the content of alloy constituents and I soon was aware that while one sort of magnesium turnings delivered dechlorinated water practically free of hypochlorite, other scraps employed under exactly the same conditions left in the filter effluent a distinct, although small, content of hypochlorite. This matter requires still further investigation. It is highly important that the magnesium metal shall be absolutely free of carbide because the slightest content of such compound evolves acetylene gas and imparts to the water a disagreeable smell. The carbide occurs sometimes in magnesium produced by electrolytic processes and is apparently derived from the graphite (carbon) electrodes.

The products resulting from the reaction of chlorine with magnesium metal are highly soluble in water. Therefore, there is no formation of protective coatings to block access of chlorine in the water to the metal surface. On the other hand the minute amounts of the

*Emscher River Board.

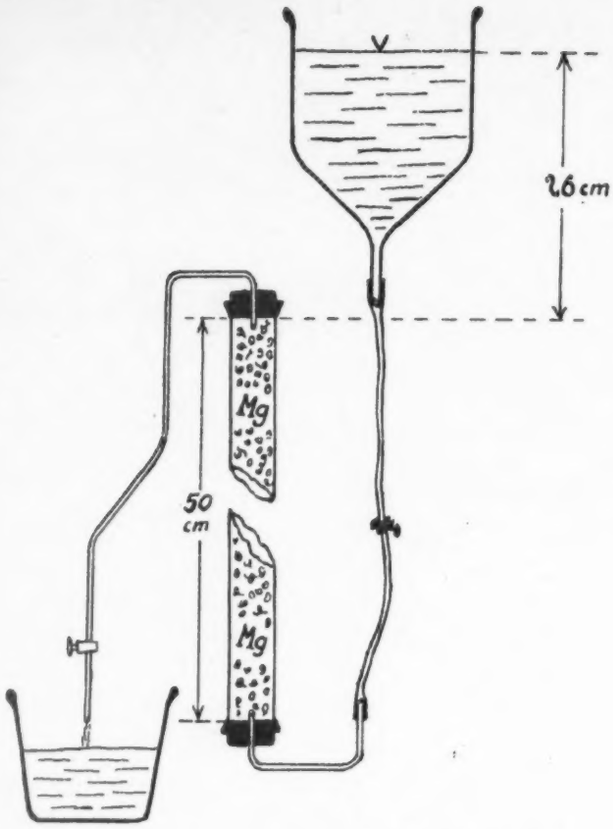



*Fig. 2—Simple Laboratory Arrangement for Dechlorination, Decarbonization and for Raising the pH Value of Water.*

magnesium compounds dissolved in the water are not of any hygienic importance because magnesium salts are found in most natural waters while several so-called mineral-waters contain large quantities of such salts. Likewise the small increase of magnesium content raises the hardness of the water to a negligible extent only.

## Laboratory Experiments

In the following experiments I used tap water which had been chlorinated to produce a persistent free chlorine residual of 0.5 p.p.m. This water had a very distinct chlorine taste and smell and reacted with iodostarch-solution to produce a strong blue color. I filtrated this water through a tube filled with carbide-free magnesium turnings (see Fig. 2) at a rate of 1 litre in 45 sec. under a hydrostatic pressure of 26 cm. The effluent of the filter proved to be for hours (as long as the experiment lasted) absolutely free of any taste or smell and when tested with iodostarch-solution remained colorless. Only after acidification did there appear a faint tinge of blue caused by the trace of hypochlorite formed in the course of filtration. This was too small, however, to detract from the dechlorination effect.

In order to employ a very taste-sensitive test I added to this effluent 0.05 p.p.m. of pure carbolic acid. Since, by this addition the water did not acquire any detectable taste or odor it was evident that dechlorination was complete.

However, when I added to the same chlorinated water the above mentioned amount (0.05 p.p.m.) of phenol *before* the filtration, the water acquired a very strong and disagreeable chlorophenol taste and odor. Tested with iodostarch-solution there appeared a distinct blue color, proving that only a fraction of the chlorine was combined to chlorophenol, the rest being still present as free chlorine. After *filtration* of this chlorinated-chlorophenolated water through magnesium turnings there resulted an effluent only slightly reduced as to the bad tastodor but completely freed of the unbound chlorine because not reacting with iodostarch-solution. Evidently the magnesium filter removes free chlorine but not the compound "chlorophenol."

## The Cost of Dechlorination

Assuming that after heavy chlorination there remain in the water 0.5 p.p.m. free chlorine to be removed and that only 80 per cent of the weight of the magnesium scraps becomes really utilized in the $MgCl_2$-forming reaction, there arises a demand for about 2 pounds of magnesium per million gallons of the chlorinated water. Thus a waterworks supplying a city of 100,000 inhabitants with a water consumption of 100 gals. per capita daily would require yearly for dechlorination some 7,300 pounds of magnesium. As magnesium scraps, turnings and similar materials are not yet regularly marketed, it is difficult to ascertain exactly the cost for the above amount of the metal, but in any way the daily cost per capita would not exceed 0.05 cents and would, therefore, be negligible if compared with the cost of the other necessary water treatment. A magnesium filter requires a small space comparatively, and is easy to construct and to handle because it consists essentially of a simple container fitted with a few valves. After the velocity of the flow of the water to be dechlorinated is determined it is only necessary to refill the filter at intervals with the magnesium scraps. In order to avoid the possibility that some disintegrated minute particles of magnesium may be washed out and carried with the effluent, it may be advisable to add a small sand filter beyond the magnesium filter.

Compared with dechlorination by means of chemicals or activated carbon, the magnesium filter method appears to be a clean and highly reliable procedure, simple of installation and easy to maintain and operate.

## Magnesium Removes Carbonic Acid

If water contains free carbonic acid (carbondioxide) it effects a more or less corrosive action on the pipe in the distribution system. The removal of the free carbondioxide dissolved in water, the "deacidification" or "decarbonization" of the water is, therefore, a very important procedure in rendering water less corrosive and more satisfactory for domestic use.

The processes now employed for this purpose are not entirely satisfactory. The lime treatment is difficult in working because it requires a careful adjustment of dosage in order to avoid an underliming, resulting in an insufficient $CO_2$-removal, or a superliming, causing impotability of the water or heavy coatings in the pipe-system.

The carbonate treatment (i.e., filtration through crushed marble, limestone and the like) requires considerable space for the stone filters and the construction of them is expensive because the crushing of the material to a uniform size requires considerable handwork and the handling cost of the heavy material is high. Moreover, such treatment does not completely remove the free carbon dioxide. Since the natural material available—be it marble, limestone or dolomite—is but seldom absolutely free of sulphates, there may be formed on the grains coatings of gypsum which protect the particles of carbonate against attack by the water, thus lessening the action of deacidification. Then, too, if the water contains organic matter a slime-like coating is deposited on the particles to insulate them against attack.

It is also well known that artificial aeration of water

removes only a part of its carbon-dioxide content, leaving in most cases some 4 to 6 p.p.m. $CO_2$, and these quantities of aggressive carbon-dioxide are sufficient to attack iron and steel water pipes. Artificial aeration of water should, however, be regarded as a useful *preliminary* treatment, to be supplemented in many cases by a finishing or *complete* treatment.

The complete removal of carbondioxide from water becomes a very simple matter when employing magnesium filters for the purpose. The reaction may be expressed as follows:

$$Mg + 2H_2O + 2CO_2 = Mg(HCO_3)_2 + H_2$$

The product is bicarbonate of magnesium, which is highly soluble in water. The above reaction is a very rapid one and leaves not even a trace of free carbondioxide in the filter effluent. It is not restricted to a limited content of free $CO_2$ or a partial removal as is the case when employing marble or limestone filters. Even large contents of $CO_2$ are removed completely. This can easily be proven by testing the water before and after filtration through magnesium turnings by addition of a few drops of a phenolphthalein solution. The filter influent will be acid but the effluent shows a distinctly pink color, indicating absence of all free carbondioxide and the rise of the pH-value.

According to the above formula 1 kg. of magnesium metal will suffice to bind 3.62 kg. of $CO_2$. Therefore, for example, should the water contain 20 p.p.m. $CO_2$, one million gallons of such water will require 20.96 kg. (45.08 pounds) of metallic magnesium for deacidification. As in the example given under heading, "The Cost of Dechlorination," a waterworks for a city of 100,000 inhabitants would require 76,400 kg. (168,080 pounds) of magnesium yearly. While this is a very much higher figure than was the case where used for dechlorination, it remains, nevertheless, in the limits of economical operation because the financial load per capita would not exceed 0.5 cents daily. In such cases, where the content of free carbon-dioxide in the water is relatively high, it would be preferable to remove the bulk of the $CO_2$ by artificial aeration and only the difficultly removable residual by passage through magnesium beds.

Upon boiling the water which contains magnesium-bicarbonate $Mg(HCO_3)_2$ this compound breaks down to form the less soluble carbonate ($MgCO_3$) and the liberated (half-bound) carbondioxide escapes in the steam. Such transformation may be sometimes undesirable in household use of the water and likewise in some industrial uses, especially for boiler feeding. However, a simple computation shows that the increase in "hardness" from this source is small. For every p.p.m. of $CO_2$ removed by means of magnesium the hardness of the water is increased by only 0.39 p.p.m. (expressed as CaO)—i.e., 0.039 German degrees = 0.049 Clark degr. = 0.04 grains/U.S. gallon.

It is a matter of consequence that it is practicable to combine the dechlorination of water with the removal of carbonic acid in one operation, when doing the work with magnesium filters.

### Magnesium Increases the pH Value of the Water

According to formula:

$$Mg + 2H_2O = Mg(OH)_2 + H_2$$

the magnesium in contact with water (after the carbonic acid is first completely removed) sets free hydroxyl-ions because the hydrogen being set free escapes. The hydroxide of magnesium is partially ionized to produce $Mg/(OH)_2$. Although the solubility of magnesium hydroxide in water is very slight it suffices, however, to raise the alkalinity as high as pH = 8.4.

Slightly alkaline water is desired in various industries and in general for zeolitic softening and for boiler feeding purposes. Every sort of water can deliberately be freed of carbon dioxide and made alkaline to the limit of the above pH-value by passage through beds of magnesium metal, the retention time in the filter being naturally somewhat longer than is required for dechlorination or deacidification. It is, however, true that in the course of such treatment a small amount of floc of magnesium oxide-hydrate will be produced. These flocs, which may help to precipitate impurities, can easily be removed from the water by sedimentation or filtration, where such is necessary.

### Additional Applications

The applicability of metallic magnesium in water treatment practices is not exhausted with the above quoted methods. There seems to be a still further useful application of this metal in connection with the preparation of water for human consumption and for industrial purposes. Experiments now under way, especially as to the bactericidal action, are as yet not far enough advanced for reporting.

This new—and at the first glance perhaps somewhat strange looking technique of treating water by aid of metal—proves in reality to be nothing more than the utilization of the hitherto considered malicious property of waters to *corrode* metals. Corrosion—a reaction usually causing nothing but mischief—may now become reversed to produce unsuspected advantages.

## Association Meetings Scheduled

July 12-14—**Virginia Section, A. W. W. A.** Martinsville, Va. Secretary, H. W. Snidow, State Department of Health, 601 State Office Building, Richmond, Va.

Aug. 22—**West Virginia Conference on Water Purification.** Hotel Windsor, Wheeling, W. Va. Secretary, J. B. Harrington, State Department of Health, Charleston, W. Va.

Aug. 23-24—**Central States Section, A. W. W. A.** Hotel Windsor, Wheeling, W. Va. Secretary, H. L. Nelson, U. S. Pipe and Foundry Co., 2435 Koppers Bldg., Pittsburgh, Pa.

**Sept. 3-6—Annual Meeting of American Public Health Association. Hotel Huntington, Pasadena, Calif. Wilimena R. Walsh, Secretary, 450 7th Ave., New York City. The California Sewage Works Association will hold its meeting jointly with the P. H. Eng. Section of the A. P. H. A.**

Sept. 17-19—**Rocky Mountain Section, A. W. W. A.** Long Beach, Calif. Secretary, B. V. Howe, State Board of Health, Denver, Colo.

**Sept. 18-21—New England Water Works Association Annual Convention. Hotel Statler, Boston, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston.**

Sept. 19-21—**Michigan Conference on Water Purification.** State College, East Lansing, Michigan. Secretary-Treasurer, John Hepler, State Department of Health, Lansing, Mich. (Short School for Water Operators to be held 17th-19th at same location.)

Sept. 20-21—**Minnesota Section, A. W. W. A.** Duluth, Minn. Secretary-Treasurer, R. M. Finch, 414 Flour Exchange Bldg, Minneapolis, Minn.

Sept. 24-27—**American Society Municipal Engineers.** Rochester, N. Y. Secretary, C. W. Sammelman, 4359 Lindell Boulevard, St. Louis, Mo.

Sept. 26-28—**International Association Public Works Officials.** Hotel Sagamore, Rochester, N. Y. Secretary, A. M. Anderson, 100 N. La Salle St., Chicago, Ill.

Oct. 15-18—**Southwest Water Works Association.** Hotel Hilton, Waco, Texas. Secretary, Lewis A. Quigley, Superintendent Water Department, Fort Worth, Texas.

Oct. 24-27—**California Section, A. W. W. A.** Long Beach, Calif. Secretary, J. E. Phillips, Department Water Supply, 207 Broadway, Los Angeles, Calif.

Oct. 29-31—**Pennsylvania Water Works Association.** Haddon Hall, Atlantic City, N. J. Secretary, F. H. Snow, 507 Telegraph Bldg., Harrisburg, Pa.

# 54TH CONVENTION OF THE AMERICAN WATER WORKS ASSOCIATION

THE American Water Works Association held its 54th Annual Convention in New York City, June 4th-8th. Meeting all predictions and expectations, it proved to be the best convention held by the association in several years—was interesting, lively, successful. The registration was 891—the attendance more. Exhibits of water works materials and equipment numbered 75.

The convention was opened by an address of welcome delivered by Maurice P. Davidson, the new Commissioner of Water, New York City. Mr. Davidson was loud in his praise of W. W. Brush who after 40 years' service retired as Chief Engineer of Water Supply just prior to the convention.

To Leonard P. Wood, Engineer, Board of Water Supply, New York City, went the honor of having been selected as the Diven Medalist of 1934. The member who has best served the association during the year is voted this award. Mr. Wood's work on protective linings and coatings for pipes, for the Committee on Cast Iron Pipe, was so recognized.

To Colonel W. T. Chevalier, Publishing Director, Engineering News-Record, went the John M. Goodell award which is voted the author of the best paper appearing in the A. W. W. A. Journal each year—"Public Works and the Economic Scheme" being the title of the inspiring paper presented in 1933 by Col. Chevalier at the Chicago convention.

*Malcolm Pirnie, New York City, Retiring President.*

*Harry E. Jordan, Indianapolis, Ind., Incoming Pres.*

As a token of esteem and appreciation of his several years of service as Secretary of the Water Purification Division, Harry E. Jordan, retiring to take over the presidency of the association, was presented with a handsome desk set of twin pens.

For the greatest gain in new members during the year, the Hill Cup was awarded the Canadian Section with the California Section following closely. Under the guidance of A. U. Sanderson as Chairman and A. E. Berry as Secretary, the Canadian Section has made rapid strides and the publicity work of this section is to be commended to the attention of other sections of the association.

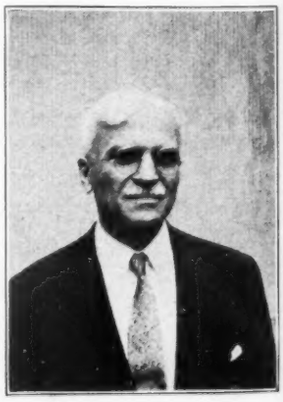
Joseph M. Schmidt of Lewistown, Montana, was awarded a trip to the New York convention by the board of directors in recognition of his work for the Montana Section.

President Pirnie announced a signal honor to an esteemed member, Samuel B. Morris of Pasadena, Calif. (1933 Diven Medalist), who was prevented from attending the convention because of the dedication of the Pine Canyon Dam, built under his direction and changed in name by Pasadena officials to the Morris Dam. The association passed a resolution expressing its "approval and appreciation of this recognition of a distinguished member." Those who attended the theatre party at Radio City's Music Hall saw a news-reel of the dedication exercises at which Herbert Hoover, Engineer and ex-President of the United States, officiated. Elsewhere in this issue is a brief description of the Morris Dam which is pictured on the front cover.

Harry E. Jordan, of the Indianapolis Water Company, Indianapolis, Ind., was unanimously elected president to succeed Malcolm Pirnie who was voted high appreciation for his work and ceaseless efforts in behalf of the association. W. W. Brush as Treasurer and Beekman C. Little as Secretary were unanimously re-elected to these offices.

*At the Dedication of the Morris Dam: Samuel B. Morris Turning on the First Water While Ex-President Herbert Hoover Looks On.*

Sheppard T. Powell, Chemical Engineer, Baltimore, Md., was elected Chairman, and C. R. Cox, Secretary of the Water Purification Division. Frank M. Winder, Supt. Water Dept., Trenton, N. J., was elected Chairman of the Plant Management and Operating Division. John H. Murdoch, Jr., Uniontown Water Co., Washington, Pa., was elected Chairman of the Finance and Accounting Division. Guy C. Northrup, Hydraulic Development Corporation, New York City, was elected President of the Water Works Manufacturers' Assn., to succeed W. J. Orchard, Wallace & Tiernan Co. John Keinle of Mathieson Alkali Works was re-elected Secretary.



*Leonard P. Wood, Engineer, Board of Water Supply, New York City. Diven Medalist* 1934.

## Report of Secretary and Treasurer

Secretary Beekman C. Little reported that $54,800 had been spent by the association during the fiscal year—$5,600 less than in the previous year—and the budget for the coming year was $55,950. There had been a net loss in membership of 169 in the face of 224 new or restored memberships during the year. He announced the creation during the year of the Virginia Section, which had formerly been the Virginia Water and Sewerage Works Association. During the past 5 months dues had been coming in at an increased rate as had new and restored memberships—both being good signs for continued improvement. Mr. Little announced the completion of a 220 page Index of the A. W. W. A. Journal compiled by A. V. Ruggles and now ready for distribution.

In presenting the Treasurer's report, W. W. Brush stated that the association was $3,934 better off than a year ago. Investments, amount now to $34,000, were in good shape and yielded an annual income of $1,595.

## Water Purification Dinner Best Yet

Among the entertainment features of the 54th Convention, the Annual Dinner of the Water Purification Division was outstanding. Featuring the "Native Home Grown" W. P. D. Minstrels, which consisted of the double quartet pictured here, with "Bill" Orchard serving as head-man and master of ceremonies, certainly put on a whiz-bang of a show. With the Chairman of the Division, George Norcom, as end-man singing "Wagon Wheels" and George Haggeter, one of Bill's organization, singing the "Old Spinning Wheel" the encores were deafening. And; here's a parody (words by Bill Orchard) on the "Last Round Up" that also had to be twice repeated with the audience joining in on the chorus.

## Get Along Old B-Coli—Get Along!

*(Tune: The Last Round Up)*

*We're looking for a drop of Water!*
*Da-da-de-da da-da da-da,*
*Water that is sparkling, clear, pure and swe-e-e-e-et,*
*Da da da da,*
*Water that is surely soft and heal——thy,*
*Da da da da,*
*We're looking for a d-r-o-p of water.*

*Get along old B Coli,*
*Get along, get along,*
*Get along old B Coli, get along*
*Get along old B Coli, get along, get along,*
*Get along old B. Coli, get along.*

*We'll purify that drop of water,*
*Da-da-de-da da-da da-da,*
*Chase all the bugs away—make them d-ie-I,*
*Da da de da,*
*How we do it is really our own business,*
*Da da de da,*
*We'll purify that drop of water!*

*Get along old B Coli, get along.*

The superb singing of Miss Anna Reichl, one of Bill's Maplewood (N. J.) neighbors, was an added feature of no mean proportion as attested by the audience. The more than 350 attending the largest Water Purification Dinner, gave "Bill and his Gang" a big and deserved hand.

One will remember this occasion as the last dinner attended by our esteemed George W. Fuller (Honorary Member) who had done so much for the good of the association. Mr. Fuller closed the last chapter of a book of wonderful achievements in the field of waterworks and sewerage shortly after the convention—these being outlined on another page in this issue.

The smoker this year took the form of a Supper Dance with a high class floor-show (cabaret style) put on before and after the supper. High light: Harry Ferguson at the mercy of a wrestling dame, being rolled in the wax dust in mid-floor.

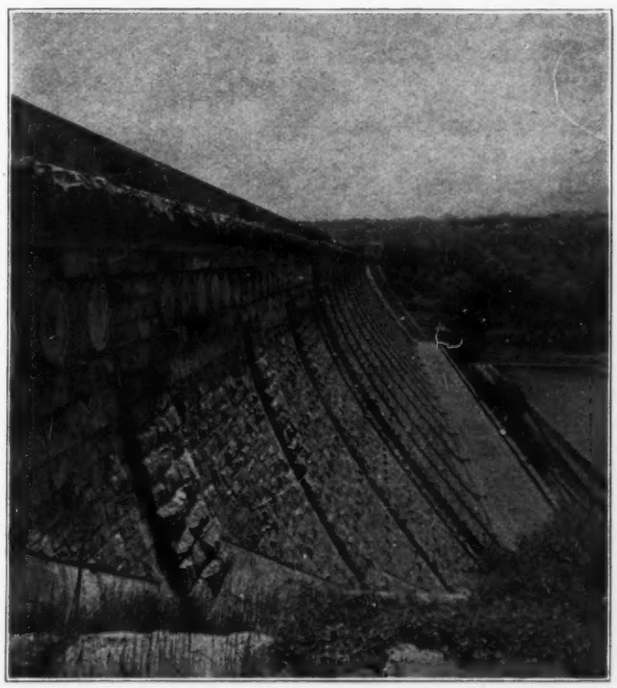
## No Code for Municipal Water Works

Preceding the opening of the convention there was held an open meeting of officials of municipally operated water works, the purpose being an open discussion of the practicability and advisability of drawing up a Code of Fair Practices for Municipally Operated Water Works. The meeting was attended by Leyton Peebles, NRA Administrator of Public Utilities, and after some discussion and questioning there appeared to be serious doubt that a Code could be enforced in a municipally operated utility and, furthermore, the advantages to be gained seemed to be of doubtful value. To attempt to come under the Code already submitted by the Water Utilities Institute, for Water Companies, was considered ill-advised. Administrator Peebles admitted that the advantages of a Code for a municipal utility would be primarily psychological value and therefore there was no imminent need of such a Code. One argument against a Code for municipal water works was the fact that workers in other city departments would look upon the advantage gained, if any, as discrimination in favor of Water Department employes. The consensus of opinion was that there should be no further attempt to establish a Code for Municipal Water Works.

## Outings—Trips—Golf

One feature of the Convention was the boat trip up and down the Hudson River where the U. S. Fleet lay at anchor. Those on board had an excellent close-up review of Uncle Sam's sea fighting equipment and the sky-line of Manhattan Isle from Battery to Bronx.

At the close of the Convention a special all-day inspection trip was made to points of interest and beauty on New York City's water supply system, including Croton and Kensico Dams, aerator, control works and chlorinating station.



*An Impressive View of the Kensico Dam. (Photo by E. Nordell.)*

*The Home Grown W. P. D. Minstrels. Left to Right: George Norcom (Federal Water Service Co.); Ed Orchard (The Stage); Ed Reilly (W. & T.); Elan Johnston (W. & T.); Bill Orchard (W. & T.); Colonel (Jde) Wrench (Ind. Chem. Sales); Joe Wafer (Ind. Chem. Sales); Geo. Haggeter (W. & T.); Jack Butler (Ind. Chem. Sales)*

In the golf tournament, W. J. Wilson of Greenwich, Conn., won the cup for the Active member with low gross score. M. J. Siebert of Richmond, Va., was the Associate member (Neptune Meter Co.) to win first prize for low gross, shooting a 78 on the difficult Ardsley Club course. Others to win prizes were: W. T. Miller, R. K. Blanchard, P. L. McLaughlin, W. H. Clark, F. H. Mueller, L. J. Evans, J. J. Garland, B. C. Little, I. M. Glace, Karl M. Mann.

## Superintendent's Round Table Discussion a Feature of Plant Management and Operating Division*

(Carl A. Heckmer presiding)

In opening the session the Chairman announced that henceforth three directors would be named to function for the M. & O. Division with the view of bettering its arrangements of program and in other ways strengthening the division.

The following Round Table Topics were discussed:

**"Reconditioning of Large Mains"**—W. W. Brush (Leader).

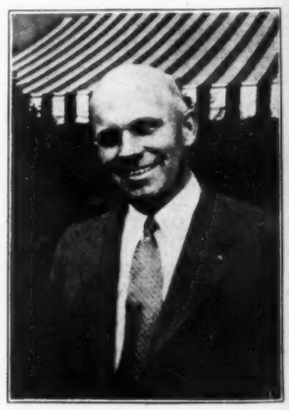
Mr. Brush stated that cleaning and coating old water mains had proved a practical and economical method of extending the life of such mains indefinitely. He cited experiences of the New York Department of Water Supply during the past three years, in which it had been found that wire brushing of the interior followed by hot application of Bitumastic Enamel was satisfactory and less laborious and costly than the original scheme of sand blasting to the clean metal before coating. After 3 years of service the coatings applied to the wire brushed pipe interior had been found in excellent condition. Considering this a scheme of buying added pipe line capacity at a very low cost, plans had been laid to extend the reconditioning program considerably on New York's system.

Mr. Brush, in reply to a question as to what scheme might be applied to mains too small to enter, stated that a scheme now under trial and development, with promise of success, involved pipe cleaning by tool run through once or oftener and this followed by application of cement mortar applied by a revolving-head and self-propelled machine. The use of cement-mortar had the advantage of requiring no drying of the pipe walls prior to application of the protective lining. (For a more complete discussion of "Reconditioning Water Mains," see Mr. Brush's article in the June issue of Water Works and Sewerage.—Ed.)

The Chariman referred to the same or a similar scheme of main reconditioning being prosecuted in Newark and Jersey City, N. J., and asked for a report on these projects by representatives if present. There being no one connected with these projects present, a representative of the Wailes, Dove, Hermiston Company reported on the successful reconditioning and coating of about 12 miles of mains, carried on as C.W.A. projects.

Ross Dobbin, Manager of Utilities, Petersboro, Ontario, called attention to a method employed in England—the Eric Process—wherein the cleaned main was filled with an asphaltic emulsion in water. An electric potential applied to the pipe caused the asphalt to be deposited

*Carl A. Hechmer, Hyattsville, Md., Chairman, Management and Operating Division.*



*Roger W. Esty, Superintendent, Water Department, Danvers, Mass.*

**Note: Elsewhere in this issue appears a separate report covering the meetings of the Water Purification Division which has been prepared by John R. Baylis, Associate Editor.*

on its walls. He had had no first hand experience with the process but understood it to be practical and effective if properly applied.

FRANK C. HOPKINS, General Manager, Consolidated Water Company, Utica, N. Y., offered a recent and interesting experience in checking tuberculation of a 24-inch gravity supply main at Utica. This 24-inch pipe line had been cleaned on numerous occasions after which the tuberculation apparently came back quicker than prior to cleaning. Since a recent cleaning this rising loss of head, due to friction created by the roughness of tuberculation, had not put in its appearance and in fact the friction loss seemed to be on a gradual decrease in distinction to increase as previously experienced. It was their thought that the reason for this could only be attributed to the recently started application of ammonia and chlorine at the reservoir inlet to this feeder main.

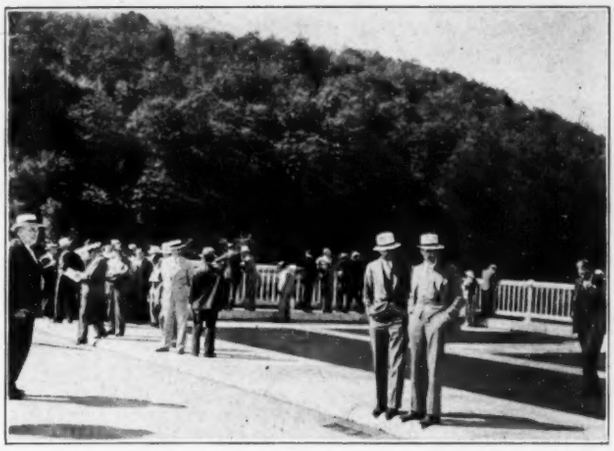
J. WALTER ACKERMAN, Consulting Engineer, Munnsville, N. Y., at a later point in the meeting (transferred to this position as amplification of Mr. Hopkins remarks) stated the history of experience with the Utica main. The original coefficient had dropped in 16 years of use to "C" = 90. Past history had shown that cleanings had in each case boosted "C" to between 132 and 142 which within 2 years thereafter dropped to 110 and 115, necessitating recleaning. The last cleaning had raised "C" to 144 which was not alone holding but seemed to be gradually increasing. This he attributed to the sterile conditions brought about by the residual chlorine in the line in the form of chloramines, produced in the ammonia-chlorine treatment. Since cleaning, there had been a rise of "C" to 150 or 152 as determined by carefully checked measurements, i.e., an increased capacity of the main, amounting to 400,000 gals. per 24 hours.

(The Utica experiences and that at other points where the ammonia-chlorine treatment has been effective in correcting corrosion (red or black water troubles) on dead ends would seem to bear out the assumption that biological action is responsible for much in the way of tuberculation and corrosion. This circumstance if further confirmed will constitute the most important development technically and economically of any revealed in recent years.—Editor.)

**"Taste and Color Troubles in Dead Ends"**—MALCOLM PIRNIE (Leader).

Mr. Pirnie said that taste, odor and color being more pronounced in dead-ends and sluggish flow points than

*The 1,000-Ft. Spillway at Croton Dam. Water Formerly Wasted Is Now Lifted Into the Catskill Aqueduct by the New 180-M.G.D. Croton Pumping Station.*



*A Group at Croton Dam, New York Water Supply. (Photo by E. Nordell.)*

elsewhere on the system was an indication of what was taking place at such points. Indications pointed strongly to depletion of oxygen by biological action due to a form of fermentation and finally putrefaction and odors—sometimes of hydrogen sulphide—resulted. Corrosion and color production went hand in hand with fermentation, as could be fairly well demonstrated.

Experience had shown the ammonia-chlorine treatment to be effective in correcting these troubles—most likely by suppressing biological activity. He cited the Utica treatment which, having been proposed as a corrective measure, had so far proven effective in checking tuberculation and corrosion.

The use of lime or alkalies to raise the pH value of waters had been effective but with soft aggressive waters was less or more difficultly so. Dead end troubles continued in modified form requiring wasteful blow off and continuous bleeding practice. He cited personal experiences at Providence, R. I., and Palm Beach, Fla., where suppression of corrosion on dead ends had required a pH value of 9.2 or thereabouts. As indication that tuberculation may be primarily dependent on biological action, Mr. Pirnie cited observation of tanks wherein the tuberculation increased with the depth of water and where none appeared above the minimum water line in a fluctuating tank. This observation was confirmed by Mr. Yaxley of Waterford, N. Y., and another member reported trouble from pitting of cement lined pipe on a dead end which had raised the alkalinity of the water to about 600 p.p.m.

W. W. BRUSH said that blowing off dead ends on parts of the New York City system had been necessary every 2 weeks at times. Subsequently chlorination had been helpful in reducing dead end troubles. On all cement linings their requirement was that the cement be protected with approved asphalt paint impregnation and a spray coating applied to the surface to prevent leaching of lime from the cement. They had so far felt that raising pH of the N. Y. water for corrosion control to be impractical. (See report of Dr. Hale on "Pipe Corrosion Experiments" at a later point in this meeting.—Ed.)

M. C. SMITH, Engineer of Water and Electricity, Richmond, Va., stated that there had been a universal report of improvement of water quality on Richmond's dead ends following adoption of the ammonia-chlorine process which carried high chlorine values to these points. It seemed apparent to him that the troubles had been created largely by biological action accentuated in warm weather.

JAMES E. GIBSON, Manager Water Department, Charleston, S. C., said that a pH of 9.4 had to be maintained to stop corrosion of mains by the soft water supplied Charleston. Such treatment, tried for a time, had resulted in complaints from manufacturers of yeast and bakers, because such high alkalinity proved deadly to yeast cultures. C. A. HECKMER had had similar experiences with those of Mr. Gibson.

**"Enamel Linings for Pipes"**—LEONARD P. WOOD (Leader).

Exhibiting two specimens of C. I. pipe laid in 1863 Mr. Wood explained that the Scotch pipe, practically closed by tuberculation, was not protected whereas the second was in almost perfect condition because the original tar dip had not been penetrated. The earliest application of hand applied tar coating of New York aqueducts dated back to 1914 and was applied under Thos. Wiggin's direction. Eighteen years later, this was found to be in good condition and now for the past 4 or 5 years enamels of coal-tar pitch with a mineral filler had been in commercial production. New York Department of Water Supply specifications called for tar base enamel applied to produce no less than 1/16 inch thickness.

ROGER ESTY, Superintendent, Water Department, Danvers, Mass., recited experiences indicating that bitumastic lined pipes required protection from hot sun to prevent sagging if the enamel was also to stand low winter temperatures without cracking. Tapping and cutting the pipes, however, had not injured the lining. On dead ends, where cement lined pipe had been employed, it was necessary to resort to constant bleeding to insure complete replacement of the water every 4 days to prevent complaints by consumers of hard water—this being found unnecessary with pipes lined with bitumastic enamel.

**"Large Unprotected vs. Small Protected Risers for Tanks"**—H. W. FORD, Pittsburgh-Des Moines Steel Company (Leader).

Mr. Ford thought there was little room for argument on this question because the use of large diameter risers had become almost universal practice. There were no advantages and several disadvantages when using protected risers—one being wood-pecker hammer. Others were in agreement—one member having bought an anti-woodpecker paint from a glib salesman—but, "woodpecker troubles" still persisted.

**"Special Sprinkling Rates"**—R. B. SIMMS, Superintendent, Water Works, Spartanburg, S. C. (Leader).

Mr. Simms' 14 years in plant management had led him to favor establishment of special rates to cover consumption for lawn sprinkling, patterned after the electric utilities scheme of special rates to encourage increased use of current for cooking and other household operations. He made it plain that water was available and filtration plant capacity was sufficient at Spartanburg to justify such a scheme of encouraging increased consumption at increased income to the water department. To arrive at the volume of consumption to be charged at the reduced rate the average winter monthly takings by the consumer would be charged for at regular rates. All in excess would be billed at the special rate of 10 cents per 100 cu. ft. or 12.33 cents per 1,000 gals. as compared with the normal rate of 25 cents per 1,000 gals. for the first 15,000. The Spartanburg system was 100 per cent metered and they had planned added distribution storage in the form of an elevated tank of one million gallon capacity.

Several members were not in agreement with the scheme as a general practice, some feeling it to be discrimination between consumers, whereas others felt the practice sound when there was excess water to be sold even though it produced no profit. The one weakness of encouraged sprinkling seemed to be overtaxing main capacities which is the cause of prohibiting sprinkling by some cities during normal peak draft periods.

*R. B. "Bob" Simms, Superintendent, Water Works and Sewerage, Spartanburg, S. C. "We Have the Water; the People Want It for Sprinkling at Attractive Rates; We Are Going to Let Them Have It."*

No one argued the value of encouraging sprinkling from the standpoint of beautification of residential sections, such having a decided value to the community even though no direct profit accrues to the Water Department directly.

Mr. Simms closed the discussion by a clean cut statement that "they in Spartanburg had the water; the people wanted it for sprinkling; and, they were going to let them have it."

**"Rust vs. Mill Scale on Tanks and Standpipes"**—JAMES E. GIBSON (Leader).

Mr. Gibson's experience led him to favor allowing metal of tanks, etc., to rust before application of paint and thus eliminate all mill scale. He favored priming coats of red lead and linseed oil over which aluminum in varnish is used for the final coats. For tank interiors Bitumastic enamel applied hot had stood for 8 years at Charleston without a sign of deterioration. In another instance red lead and aluminum paint on the interior of a stand-pipe had been effective during 8 years—no rust appearing at rivet heads 45 feet down in the standpipe.

**"The Use of Cone Type Valves"**—E. S. BRISBANE, Engineer, S. Morgan Smith (Leader).

Mr. Brisbane touched on the several advantages of

*ON THE HUDSON BOAT TRIP*

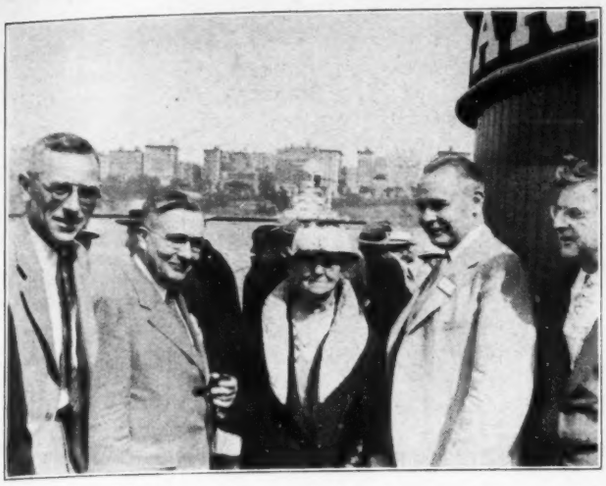
*Mr. and Mrs. P. S. Wilson of Glen Ridge, N. J.*

*Esty and Boyd Weren't Concerned with Ships at the Moment.*

*Neither Was Marsden Smith After Finding the Donaldson "Twins" on Board.*

*Eugene Cranch, Mrs. C. W. Smedberg and Mr. Smedberg (Behind the Blinders).*

*From Morgantown, W. Va., Came Professor Carpenter and Mrs. Carpenter.*



*An Important Group: Left to Right—George Norcom, Chairman, Purification Division; Harry Jordan, Incoming President; Mrs. Pirnie, Mother of President; Malcolm Pirnie, Retiring President; Bill Orchard, President of the Water Works Manufacturers Association.*

altitude and check valves of the cone type—not the least being the power saving in reduced friction through the cone type "free-way" check valve. Such savings had paid the cost of many installations in a short time.

L. R. Howson, Consulting Engineer, Chicago, Ill., said that he had used cone valves for water hammer prevention for 5 years; and, as altitude valves more recently. Especially valuable was the cone valve on sewage pump discharge lines where the pumps went in and kicked out automatically. Also these had been effectively used to protect concrete force mains and their valve, performance and dependability proven in his 20 odd installations had been thoroughly demonstrated.

S. Logan Kerr, Engineer, Baldwin-Southwark Corp., Philadelphia, Pa. (also Chairman of Water Hammer Committee of the A.S.M.E.), stated that various surge or water-hammer problems required special solutions in many instances and frequently pressure release valves were desirable in conjunction with cone check valves to make the installation 100 per cent safe under all conditions of pumping. In some cases ordinary check valves might function effectively if used in connection with proper type relief valves. Water hammer was more serious when pumping to reservoirs than direct to mains.

W. W. Brush confirmed the above by citing examples wherein the ordinary cone valve had proven satisfactory at the Ridgewood Pumping Station whereas at the Croton Reservoir Station surge relief valves had to be used in conjunction with the cone valves. He agreed with Mr. Kerr that the problem of surge relief should be tackled as an individual one in each instance. Ordinary check valves he considered obsolete, because of head loss through them and extra power requirement.

Mr. Brisbane closed by stating that the quick closing type of cone valve could be made adequate without surge relief valves, if properly regulated.

**"Fire Hydrant Painting"**—Ross L. Dobbin, Manager, Utilities, Peterborough, Ont. (Leader).

Mr. Dobbin recommended use of very quick drying paint of color to suit. He warned against an attempt to use paint scrapers which seemed to put more paint on bystanders and passers-by than on the hydrant. Frequency of painting will depend upon need and the available money for such work—preferably once each year for appearance if not for protection. Painting in winter was warned against.

The value of standardization of fire hydrant painting to distinctively indicate the capacity of each hydrant and main on which located, was discussed. Such a practice is being evolved in New England municipalities for the benefit of fire fighters.

One member reported that chains on fire-hydrant caps were a nuisance and he had therefore removed them with no difficulty from loss of caps or damage. Chains, after painting, were very likely to give trouble due to their stiffness. Very satisfactory results from the use of Du Pont's "Du-Lux" (laquer) paint on hydrants was reported by members who had tried it.

C. A. Heckmer reported that considerable thought had been given to hydrant color schemes in the Washington Suburban District in order to combine beauty and conspicuity which led up to a combination of gray and green in residential areas.

W. W. Brush said the New York practice was to paint every hydrant once in 5 years and the domes every 2 years. The color scheme being black barrel with aluminum domes and caps. The contracted cost per hydrant painted had averaged about 30 cents.

**"Adjusting Excessive Water Bills of Indignant Consumers"**—W. S. Patton, Manager, Water Department, Ashland, Ky. (Leader).

Mr. Patton related a typical case of an excessive water bill created by a quietly leaking flush tank. The meter was found accurate and correctly read and therefore neither the Water Department nor the consumer could be held to blame. Cases of this nature justified compromise and a reduced billing of all water registered which was in excess of the average consumption between meter readings. In the final analysis such adjustments were far preferable to making an enemy of customers who have unwittingly wasted water.

C. M. Crowley, Registrar of Water, St. Paul, Minn., said that under such circumstances (leaks unknown to the customer) the excess of the bill was split equally between the customer and the Water Department—i.e., a 50 per cent credit was allowed as adjustment.

E. T. Cranch, Manager, New Rochelle Water Company, New Rochelle, N. Y., called attention to a ruling by the Public Service Commission of New York State which prohibits a water company from making any adjustment on excessive water bills. A case of under-

*ON THE KENSICO-CROTON TRIP*

*While John Ward Explains to John Law, Kuhn Finds Out How That Dreaded Whistle Works.* *Pierce, Ruggles, Hansen, Gelston* *Professor Carpenter and Scotland G. Highland,* *Both West Virginians Enroute on Bus No. 1*

ground leak costing a customer $60.00, during the quarterly period between billings, was taken before the Commission but an adjustment on the bill had been refused.

W. V. Weir, Superintendent, St. Louis Co. Water Company, University City, Mo., reported that the Missouri Commission permitted some adjustment on bills if they were 5 times or more above the normal. In such cases a credit of 4 cents per 100 cu. ft. on the excess registered (above normal) was allowed.

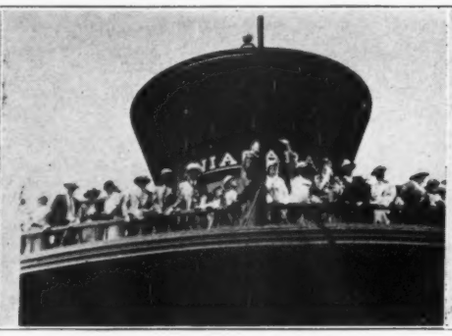
## Report of Committee on Electrolysis

Nicholas S. Hill, Jr., reporting as Chairman of the Committee on Electrolysis, outlined the results of investigation which seemed to indicate that stray and minute electric currents had been the cause of degradation of water in the pipes on the consumers' premises. Attack of meter parts (corrosion) and creation of bad odors and tastes in the water had been noted. The studies were being continued in cooperation with representatives of electric utilities.

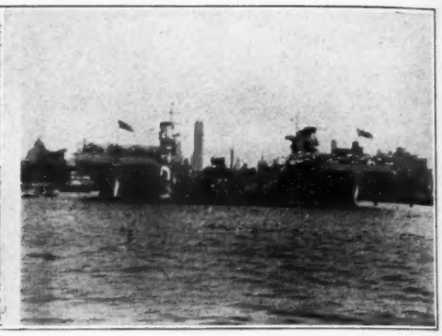
A matter of increasing concern to water companies and water departments was the recently introduced practice of house wiring economy which allowed the third (neutral) wire to be uninsulated. Such installations were potentially subject to leakage of current (by-passing) through the water piping system to create a circuit with the usual ground connection on the water piping and would result in an attack by electrolysis—principally within the building but in addition somewhat on the outside.

A resolution was offered and passed which puts the Association on record as opposing the use of the "bare-neutral" system of wiring in all buildings connected to a water system.

*One of Uncle Sam's Newest—The New Mexico.*



*Good-Bye New York—Off on the Excursion to View Uncle Sam's Fleet and Manhattan Sky Line.*



*Airplane Carriers "Lexington" and "Saratoga," Berthed in the Hudson.*

## What P.W.A. Has Accomplished in Water Works Developments

**"Water Works and the P.W.A. Outlook"**—Col. W. T. Chevalier, Vice-President, McGraw-Hill Publishing Company, New York City.

The Colonel in his dynamic style presented a review of the first year's accomplishments of the Public Works Administration—complimenting Malcolm Pirnie and the Association's part in pushing forward progress in the water works field. Lack of preparedness and plans to proceed with municipal projects had been responsible for delayed starting of work and necessitated the C.W.A. program for winter unemployment relief and incidentally a further delay in the P.W.A. program. Now, however, the ball was beginning to roll and during the first 5 months of 1934, 58 per cent of all water works contracts let east of the Rocky Mountains were P.W.A. projects, representing roughly a 60 per cent net gain over awards in 1933. There had been a steady increase of 3 lettings of contracts per week since January, 1934—there being 21 in May as against 12 in January. Sales of municipal bonds had increased 155 per cent during that period.

The basis for continued programs of public works construction called for the following essentials: (1), A guaranteed continuity being essential for future planning and assurance; (2), Must create tangible assets—not merely unemployment relief; (3), Excess bank reserves requiring an outlet could well be put into municipal betterments rather than loaned brokers for use in a new orgy of speculation; (4), Local projects would put life-blood into the program of relief and recovery by effective distribution of funds.

He added that Congress was favorable to extending the P.W.A. program so well started, but the Administration (President Roosevelt and his advisers) had yet to be convinced that it was the most effective scheme to pursue.

Abel Wolman, with first hand experience as P.W.A. and C.W.A. Engineer and Adviser, was well equipped to discuss this topic. He painted no rosy picture of the general effect of an unemployment and municipal relief program via public works construction beyond the period of emergency and dire necessity. He pointed to the fact that, lacking something more sound, the C.W.A. and P.W.A. program was put into effect even though it paralleled what Great Britain had been doing for the past five years with the net result that even larger lists of unemployed had been created. The C.W.A. program was in effect the British Dole on a modified pattern. In the final analysis it was an encouragement toward being supported by government money and therefore a throttle on industrial development and private initiative. Private financing being inherently correct the quicker the return to this normal and healthful American scheme the better.

The experience of P.W.A. and C.W.A. had shown that the greatest need for unemployment relief had existed in municipalities absolutely unable to finance public projects. That meant no local relief by P.W.A. and of necessity required the more gratuitous C.W.A. which had supplied outright grants of 66 per cent and even 100 per cent of the cost of the projects. Further, too many municipalities developed a readiness to take all help they could get without thought or intent of repayment.

Mr. Wolman said that he was, of necessity, forced to conclude that: (1), In future public works planning greater accuracy and soundness of project and less emotion was an essential; (2), Added spending by poor communities, least able to repay but most needful of betterments, was of questionable soundness; (3), The question of the probability that permanent readjustment

was being sacrificed for a temporary advantage, by release of government funds, was one which needed careful consideration in future planning.

The views of Colonel Chevalier and Mr. Wolman were particularly interesting in being so diametrically opposites in future planning. But, Mr. Wolman conceded the expediency of the C.W.A. at a critical moment in America's history and the good of the net result from the P.W.A. program. He did, however, take the position that financing of rather than support of unemployment relief is the basically sound procedure in future planning. Further, that private financing should not longer be stifled by encouraging municipalities to seek federal gratuities.

## The Cause of Chicago's Amoebic Dysentery Outbreak

**"Significant Features of the Chicago Amoebic Dysentery Outbreak"**—JOEL I. CONNOLLY, Chief, Bureau of Engineering, Board of Health, Chicago, Ill., and ARTHUR E. GORMAN, Filtration Engineer, Bureau of Engineering, Chicago, Ill.

Messrs. Connolly and Gorman reported on the cause and results of the largest amebic dysentery outbreak on record—that experienced in Chicago during the last half of 1933, originating in two connected and prominent hotels, resulting in 850 known cases and 52 known deaths up to May 15th, 1934.

Tracing the source and cause of the infection (at first attributed to food handling carriers) revealed that a sewer suspended above a large drinking water cooling tank in the basement had leaked into the latter and particularly so when the sewer had been surcharged due to heavy loading on the system, from within, coincidentally with surcharged city sewers during heavy storms. In addition there were located cross connection valves between the sewer and a condenser water tank but there was no direct proof that leakage through these connections was responsible. Tests to prove or disprove the possibility of toilet syphonage into the water system indicated that this was not the source of the contamination. The confinement of the outbreak to employees and guests of the two hotels indicated the trouble to be local to these establishments. The fact that typhoid fever and other intestinal diseases did not appear along with the amebic dysentery was explained by the lightness of the pollution, which was not more than the residual chlorine carried in Chicago water, was capable of rendering free of the more susceptible organisms but had not been capable of destroying the highly resistant (encysted) amoeba organism. In tracing the possibilities that water from various sources reached different parts of the hotel, super-chlorination and orthotolidin readings were employed.

As the result of this disastrous outbreak and the difficulty of tracing out pipe systems in these hotels, Chicago has passed regulations requiring all water lines be painted a distinctive color. The lesson learned was that periodic inspection of plumbing systems of large buildings is of high importance.

Mr. Gorman said that amoeba in the encysted form had been proved resistant to 25 p.p.m. of chlorine and would survive in water for 10 days at least, but could be removed by coagulation and filtration.

ABEL WOLMAN, in discussion, complimented the authors on the efficient and thorough investigations conducted. The lesson of hazard from cross connections had once again been learned, notwithstanding existing regulations prohibiting such. Such hotels were no less than vertical cities when considering the 83,000 people

*L. D. Gayton, City Engineer, and Arthur Gorman, Filtration Engineer, Chicago, Ill.*

which had lived in them during the year. Therefore, why was it not logical that sanitary engineering supervision be provided by the owners to safeguard such a population. While cities were effectively producing a safe water and caring for the sewage, such outbreaks called greater attention to the growing need for environmental sanitation.

(NOTE: The Chicago experiences led the Board of Directors of the A.W.W.A. to demand that future convention hotels produce a certificate indicating that their water supply system had been inspected and was safeguarded against potential pollution through cross connections or hazards such as were found in the Chicago hotels.—Editor.)

**"Features of New York City's Water Program"**—W. W. BRUSH, Chief Engineer, Department Water Supply, New York City.

Mr. Brush said that the Croton supply was drawn on for 326 m.g.d. and 565 m.g.d. came from the Catskill supply. The new lift station at the Croton Reservoir delivered 180 m.g.d. into the Catskill aqueduct which heretofore had gone to waste over the spillway. By revamping the Old Croton aqueduct its capacity had been raised from 40 m.g.d. to 80 m.g.d. and extensive reconditioning of steel and iron mains to incresae carrying capacities was the next item on the program. Pumps had been so radically improved since 1912 that replacements of installations up to that year were now justified and being undertaken. Leakage surveys had reduced the wasted per capita consumption from 141 gals. in 1931 to 128 at present. The aquaphone method along with pitometer surveys had been used and with the former but two openings had been required to locate and stop a leak. The Long Island ground water supply was being rapidly depleted and air-conditioning practice had put an added load on New York's system. The future supply would be taken from the Delaware water shed just to the west of the Catskill shed.

LEONARD P. WOOD, Engineer, Board of Water Supply, New York City, in discussion, stated that New York had been criticized for not metering its supply more adequately. At present 24 per cent of consumption was metered. The 75 per cent tenant population in the city would not be influenced in water saving by apartment house metering and therefore New York would gain little in the way of conservation by further metering. Compared with consumption in the largest cities, New York had a per capita figure of 50 gals. under the average and only 10 gals. per capita above the fully

*W. W. Brush, Chief Engineer, Department of Water Supply, New York City (Retired). Re-Elected Treasurer of the Association.*

*Dr. Frank E. Hale, Director, Laboratories, New York Department of Water Supply.*

metered smaller cities. The average rate of increase in consumption per capita was the same as that of the 5 largest (fully metered) cities. The conclusion must be the immediate necessity of getting in the Delaware supply without further delay.

**"Pipe Corrosion Experiments"**—DR. F. E. HALE, Director, Laboratories, Department Water Supply, New York City.

Dr. Hale reported the results of three series of tests covering a period of 5 years and comparing the resistance of ¾ inch steel and wrought iron (galvanized and bare); cement lined steel; lead; brass, red-brass and copper pipes to corrosion and tuberculation by the New York (Catskill) water. His findings disclosed the rapidity of choking up of bare steel and wrought iron pipes, the longer resistance of galvanized pipes, and the great superiority of brass and copper pipes in resisting corrosion and losses in carrying capacities. The most serious aspect was that of closure of the ferruginous pipes with rust, rather than a failure due to corrosion.

The application of soda ash to maintain the water at pH value of 8.4 was helpful in correcting "red" water but did not check the rate of dissolved oxygen depletion —i.e., oxide rust production and chokage of ferruginous pipes. Of the several treatments tried the addition of 5 to 10 p.p.m. of silicate of soda was the most effective in checking corrosion but considered too expensive for large scale treatment. Tests (not complete) involve addition of excess causticity by use of hydrated lime, with interesting results. To avoid addition of hardness to the water line had been excluded from the first experimental work.

The conclusions to be drawn from Dr. Hale's results are that lead, brass and copper pipes or tubing are resistant to attack by the Catskill water and therefore superior to all others compared. Galvanized pipe was satisfactory as long as the galvanizing remained and cement lined pipe compared favorably with the galvanized. That wrought iron pipes fared so poorly when exposed to Catskill water was a surprise.

**"Coagulation with Iron Compounds"**—A. P. BLACK, Professor of Chemistry, University of Florida, Gainesville, Fla.

Professor Black said that the interest shown in the adaptation of ferric salts in recent times justified a review of the situation and a look into modern developments in coagulation with ferric salts. Since ferric floc was relatively insoluble in pH range 3 to 13 and alum in a narrower range of 5 to 9 it was evident that ferric salts were more flexible coagulants and therefore useful under a greater variety of conditions than was alum. This property constituted the chief claims of iron compounds over aluminum salts. In the alkaline range iron floc would take on a negative charge, whereas it becomes positive in solutions of pH 7 and lower. In the acid range the bivalent sulphate ion was important, whereas, in the alkaline range calcium or magnesium ion was most effective in improving flocculation. Ferric salts were now available as the anhydrous sulphate (96 per cent Fe $SO_4$) or the chloride; and, "chlorinated-copperas" which had been the fore-runner of the ready prepared compounds had continued in use at Elizabeth City, N. C., since its introduction as a water coagulant by Enslow and Hedgepeth in 1927. It had been subsequently used at several other points including Providence, R. I., and, most recently, at Dallas, Tex.

At Elizabeth City color removal was being accomplished by primary coagulation with "chlorinated-copperas" at a pH of 3.8 to 4.0 and secondary coagulation (10 minutes later) by adding sodium aluminate to produce a pH of 4.8 to 5.0 for highest efficiencies. No further adjustment of the pH value had proven prac-

*Supper Dance and Smoker, 5th Annual Convention, American Water Works Association, New York City, June 7, 1934*

tical and interestingly the mains were not attacked by the finished water, assumedly because of its organic nature. At Providence, R. I., chlorinated-copperas and, lately, ferric sulphate had been adapted and used with lime dosage sufficient to remove manganese (pH 9.2 at the filters), whereupon a stable and non-corrosive effluent is produced—something not attainable with alum coagulation.

At Dallas, Tex., the problem was one of turbidity removal. Chlorinated copperas had been recently adopted* at a decided reduction in cost and increased efficiencies of coagulation. In this case coagulation was effected at high pH value. At Wilmington, Beverley Hill, San Diego, and other points in California ferric-chloride had been successfully used.

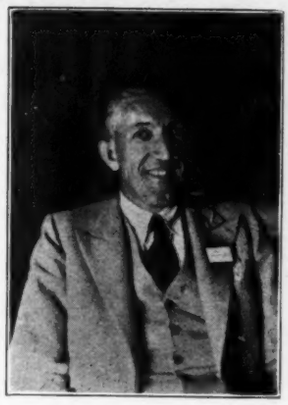
Summing up the reported advantages from ferric coagulation, Professor Black listed: (1), Coagulant is effective over a much wider pH range and for a variety of conditions—color removal being most effectively done in a zone too low for alum; manganese and turbidity removal at pH values (9 to 10), too high for efficient use of alum; (2), More prompt and effective flocculation and settling than was true in many cases with alum; (3), Effluents free or practically free of manganese, iron, aluminum; (4), Hydrogen sulphide removed by the iron, filter runs lengthened; (5), Cleaner washing filter beds.

Lantern slides of curves indicated that the zone of weakness of ferric coagulation was between pH 7 and 8.5. Lime addition to push the pH to 9 or better had corrected the trouble and simultaneously produced a non-aggressive water. Further, any neutral calcium salt would cause effective flocculation within the zone of weakness and the use of sulphuric acid in color removal would be effective and add economy where indicated.

R. W. Sawyer, Consulting Engineer, New York City, spoke from experience when he stated that ferric salts would not prove best suited for all waters; adding, that it was necessary to make adequate tests to demonstrate practicability and economy before one could recommend the use of iron salts. Further, a plant scale demonstration was necessary to determine the most effective method and point of application of the coagulant and lime, if the latter be needed.

Edgar Whedbee, Sanitary Engineer, Department Water and Sewers, Dallas, Tex., said that for 18 months experiments in chemical precipitation of sewage had been under way at Dallas and their opinion was that of the iron compounds the chloride had proved the superior coagulant. It was possible that the nearer water approached sewage the more efficient would be the chloride as compared to the sulphate.

*See Water Works and Sewerage for May, 1934—"Experiences with Chlorinated Copperas"—L. C. Billings, Superintendent, Filtration, Dallas, Tex.



*Dr. A. P. Black, University of Florida, Gainesville, Fla.*

*Edgar W. Whedbee, Sanitary Engineer, Department Water and Sewage, Dallas, Texas.*

E. L. Bean, Chemist in Charge of Filtration, Providence, R. I., said that he had compared the efficiency of ferrous and ferric sulphate on three different waters to find that about 50 per cent more iron was required when using the ferrous compound with lime. At Providence the pH range for good floc formation was from 4 to 10 but it was sluggish in the zone pH 7 to 9. Their operation bordered on causticity and floc was produced at pH 9.8 to procure efficient manganese removal and a pH above 9 in the finished water to correct corrosion.

L. I. Birdsall, General Chemical Company, said that while true that alum was low in efficiencies between pH 9 and 10, it was efficient at pH above 10.5.

Malcolm Pirnie explained that iron salts had replaced alum at Providence for the reason that manganese, iron and aluminum could be removed and corrosion checked effectively at pH 9.2 or above. Further, by their precipitation, these impurities in themselves were put to work as coagulants and only the deficiency was made up by addition of ferric coagulant.

*(This digest of papers and discussions will be concluded in our next issue.)*

*Supper Dance and Smoker, 5th Annual Convention, American Water Works Association, New York City, June 7, 1934*

# WATER PURIFICATION TOPICS

## A Report of Papers Presented Before the Purification Division at the 54th Annual Convention of the A.W.W.A.

By JOHN R. BAYLIS

*Associate Editor*

FROM the number of papers and discussions on water purification and related topics presented at the 54th annual convention of the American Water Works Association, June 4th to 7th, one might conclude that interest in the water works field is now centered largely on improving the quality of water. It is believed that this is the case. Much of the work in connection with delivering an adequate quantity of water at the proper pressure to the consumers has been more or less standardized and material changes in present methods of delivering water probably will not be made in the near future. This cannot be said about the quality of water. Each year distinct advances in improving the quality of water are being recorded. Engineers, chemists and bacteriologists have combined to produce not only safe water but water which is pleasing to the taste and suitable for practically all industrial uses. That such large quantities of water as are now used by our inhabitants can be made so near that most suitable for all needs is an accomplishment in which all connected with such developments can feel proud.

### New Officers

The following were elected officers of the Water Purification Division for the ensuing year:

Chairman—Sheppard T. Powell, Baltimore, Md.

Vice Chairman—Albert E. Berry, Toronto, Ontario.

Secretary—Charles R. Fox, Albany, N. Y.

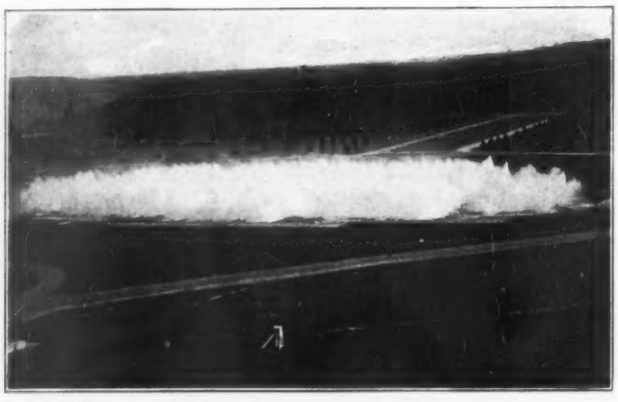
Executive Committee—Carl J. Lauter, Washington, D. C.; William M. Wallace, Detroit, Mich.; George D. Norcom, New York, N. Y.

*S. T. Powell, Baltimore, Md. Chairman-elect, Water Purification Division*

*Prof. Gordon M. Fair, Harvard University, Cambridge, Mass.*

## Papers and Discussion

**Determination of Odors and Tastes in Water by the Air Diluution Method**—GORDON M. FAIR, Professor Sanitary Engineering, Harvard University, Cambridge, Mass. The nose is a very sensitive device for detecting objectionable substances in water. A procedure for determining the intensity of the odor was described. Air which has been in close contact with the water is diluted with odor-free air to where the odor is just detectable. The water to be tested is agitated in a flask which holds about twice the volume of the water. The odor producing substances are given off in the air, an "osmoscope" is used for conveying the air from the flask to the nose. It is so arranged that the air may be diluted with definite portions of outside air as it is being drawn through the osmoscope into the nostrils. A pO scale, which is based upon the logarithm of the odor threshold to the base 2, is suggested. The limit of the osmoscope is pO of 6. This is 2 to the 6th power, or an odor threshold of 64. Higher concentrations must be diluted with odor-free water, so that the odor threshold will not exceed 64.



*The Kensico Aerator. 500 Ft. Long, 250 Ft. Wide; Has 1,600 Nozzles*

M. W. COWLES, Hackensack Water Co., New Milford, N. J., described the use of one of the osmoscopes by the Hackensack Water Co. It about doubles the sensitiveness of the odor test. Fairly good results have been obtained by the use of a glass osmoscope, whereas difficulty was encountered from odors from one made of steel. The air dilution method did not seem to be quite as accurate as the water dilution method.

**Occurrence and Control of Iron Bacteria in Water Supplies**—KENNETH W. BROWN, California Water Service Co., Stockton, Calif. Certain forms of organisms such as crenothrix, leptothrix, cladothrix and iron bacillus deposit iron on the inside surface of pipes. These deposits cause clogging of the pipes and sometimes give the water an objectionable taste and odor. There are several methods of control. Copper sulfate gives only fair results and is not recommended. Chlorine may or may not be satisfactory, and also it may cause a taste and odor. The chlorine dose should be close to 1.0 p.p.m. Ammonia and chlorine appears to be uncertain and experiments with this treatment were not encouraging. The most successful treatment was superchlorination and dechlorination with surfur dioxide. Application to the main of a strong dose of hypochlorite followed by flushing is usually satisfactory. Cleaning the mains is effective, but it must be followed by treatment to prevent the organisms from reappearing.

FRANK E. HALE, Department of Water Supply, New York City, in discussing the paper, stated that staining the organisms with iodine was the best method of iden-

tification. Based on his experience, he believes that the dose of chlorine recommended by Brown is excessive and that such organisms may be killed with considerably smaller amounts of chlorine. Trouble from iron bacteria in the Jamaica water supply and method of control was described.

WESTON GAVETT, Construction Engineer, New York City, stated that iron bacteria grew in the water at Freeport, L. I., to the extent that they caused the water to be discolored, even though the water contained only 0.3 p.p.m. of iron. Examination of the pipes showed that a thin growth about 1/16 inch in thickness covered the entire surface of the pipe.

WELLINGTON DONALDSON, Consulting Engineer, New York City, stated that the iron bacteria were found growing in the mains at Green Bay, Wis., where the water contained almost no iron, and also stated there was scarcely a distribution system, where no residual chlorine is maintained, which does not contain these organisms.

**The Spectographic Determination of Minor Chemical Constituents in Various Water Supplies in the United States**—MATHEW M. BRAIDECH and F. H. EMERY, Cleveland, O. Spectographic examination of water from a few public water supplies scattered throughout the United States showed a number of unsuspected metals in the water. This form of analysis is very sensitive. The spectograph and also the method of approximating the concentration of the compound present were described. A portion of the water is evaporated to dryness and the residue subjected to a high tension spark discharge. The relative intensity of the lines on the photograph gave some idea of the amount of each substance in the water. Thirty elements were detected by the spectograph in the samples of water from a few cities. Strontium was present in all supplies and in some as high as 10 p.p.m. Fluorine, potassium, copper, silver and zinc also were found in all supplies. The silver varied from a trace to as high as 0.2 p.p.m. in the Denver water supply. The sample from Baltimore contained an appreciable amount of lead, and some of the supplies contained an appreciable amount of nickel.

*M. M. Braidech, Chairman, Committee on Specifications and Tests for Water Purification Chemicals*

*Charles P. Hoover, Chemical Engineer, Columbus, O.*

S. T. POWELL complimented the authors very highly and stated that this method of analysis may prove highly valuable in the analysis of water for industrial use. In response to inquiry as to how the samples were collected, the authors stated that they probably were collected from water faucets, and that it is likely some of the metals found came from the faucets and pipes through which the water passed.

**A Solid Brilliant Green Lactose Bile**—FRED E. TONNEY and RALPH E. NOBLE, Board of Health, Chicago, Ill.

A new solid media for making direct counts of organisms belonging to the coli-aerogenes group of organisms was described. It is believed to have advantages over the ferrocyanide citrate agar used heretofore. The concentration of the substances in the solid media is less than that of the liquid brilliant green lactose bile. The plate is blue and organisms belonging to the coli-aerogenes group form red colonies. The incubation period need not be more than 17 hours. Some experience is required to learn how to distinguish organisms of this group. The solid media seems to be as reliable as the liquid media and gives very reliable differentiation of the organisms of intestinal origin from those of other sources.

**Report of Committee on Testing Zeolites**—CHARLES P. HOOVER, Chemical Engineer, Columbus, Ohio (Chairman).

The committee submitted a brief progress report and gave a list of tests which would be necessary to properly evaluate the zeolites. They include moisture content, weight per unit of volume, grain size, resistance to abrasion and exchange value. The committee did not give procedures for making the tests and wish to give the matter further study.

**Report of Committee on Filtering Materials**—FRANK W. HERRING (Chairman).

The committee collected data on filters from several cities. Some of the cities reported minimum filter runs of less than 3 hours. The penetration of coagulated matter into the sand bed varied from no penetration in one city to as high as 10 inches penetration in another city. The sand size varied from 0.25 to 0.5 mm. diameter for the effective size. Various rates for washing the filters were being used. Perforated plate underdrains were reported to be undesirable at Grand Rapids, Michigan. Cleveland reported a number of small mud balls present in the beds, and that there were some clogged areas along the side walls due to ineffective washing. Anthracite coal was being tried in some plants, including Columbus, O., Flint and Grand Rapids, Michigan. The committee also reported tests by James W. Armstrong on the penetration of coagulated material into filter beds. For sand of 0.37 and 0.43 mm. diameter, the penetration was 3 inches; for 0.5 mm. sand it was 4 inches; 0.6 mm. was 7 inches; with 0.76 mm. it was 10 inches.

G. GALE DIXON, Consulting Engineer, Youngstown, O., expressed doubt that the small filter units would give results comparable with those of large size units. Further, the quality of the water and seasonal variation influences the results. He stated that the underdrains at Grand Rapids were antiquated and stressed the importance of having a layer of coarse sand between the upper gravel and the fine sand. He also thought that shallower sand beds could be used in many instances.

**Report of Committee on Specifications and Methods of Tests for Water Purification Chemicals**—MATHEW M. BRAIDECH, Senior Chemist, Water Department, Cleveland, O. (Chairman).

The committee submitted a very thorough and valuable report covering specifications and methods of testing for chemicals used in water treatment. All chemicals used to any extent were included. A few suggestions for minor changes in certain parts of the report were made, but most of the discussion centered on tests and specification for powdered activated carbon. The prevailing opinion was that the phenol absorption test was the most reliable. There were some differences of opinion

as to method which should be used for making phenol determination in connection with the phenol test for carbon and it was claimed that the Gibbs' method was too complicated for the average water works laboratory.

## Symposium on Chlorination

The Symposium on Chlorination occupied a full session and was divided into papers dealing with: (a) Mechanics of Chlorination; (b) The Ammonia Chlorine Process; (c) Testing for Residual Chlorine.

**"Equipment for Application and Control of Chlorination of Small Supplies"**—C. R. Cox, State Department of Health, Albany, N. Y.

Mr. Cox described the several methods of chlorine application adaptable to small water supplies and the equipment found satisfactory. Commercial equipment available on the market was briefly described and in an appendix. Valuable tests conducted by the Division of Laboratories indicated the keeping quality of various strengths of hypochlorite solutions and the precautions necessary to insure their stability were listed. The high test hypochlorites now available which contain 65 to 70 per cent chlorine were found to be more stable than ordinary bleaching powder (chlorinated lime) and therefore more dependable. To prevent hypochlorite solutions from freezing it had been proven feasible to add ordinary calcium chloride up to 25 per cent by weight without affecting the sterilizing values of the solution. Addition of soda ash to high test hypochlorite (H.T.H. or Perchloron) solutions enhance their keeping value to a point allowing two weeks storage of solutions containing 5 per cent available chlorine without deterioration to any practical extent. The initial alkalinity of the solutions was 2 to 3 per cent calculated as sodium carbonate.

Mr. Cox felt that automatic and dependable equipment was on the whole more to be desired on small supplies than on larger ones where variations in rates of flow and quality was not so pronounced and where supervision was more adequate. The application of ammonia or its salts in conjunction with chlorination of small supplies lessened the necessity for close dosage control in that the residual chlorine in high amounts would be less noticeable to consumers. Another scheme of practical consideration for small supplies consisted of super chlorination followed later by dechlorination through carbon units, by ammonia, sulphite or sulphur dioxide application—the use of ammonia being on the whole the more practical.

The development of automatic feed devices actuated by water meters on by-pass lines or turbine type or Venturi meters on the main line, offered improved possibilities in effective and safe chlorination of small supplies highly variable in rate of flow. In conjunction with ammoniation such equipment supplies opportunities for efficiencies not heretofore easily had on a practical basis in automatic chlorination of small supplies.

**"Handling Chlorine to Avoid Trouble"**—L. L. HEDGEPETH, Manager, Technical Service, Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.

Mr. Hedgepeth's paper constituted a highly practical outline of the behavior of liquid and gaseous chlorine under various circumstances of pressure, temperature, etc. He listed and illustrated various desirable features in the design of rooms in which chlorine containers are stored, and equipment used in handling chlorine containers.

Lines carrying chlorine gas, if chilled, would create re-liquefaction of the gas and create trouble in chlorinator functioning. He pictured (by slide) such an occurrence and methods of alleviating the trouble which consisted of sloping of lines to a liquid well or trap, the maintenance of uniform temperature of the gas lines or reduction of pressures, thus establishing a lower temperature at which liquefaction would be encountered.

Methods of transporting, storing and handling one ton chlorine containers were adequately explained and illustrated. In this connection a new device for weighing ton containers, attached to the same equipment used in lifting and transferring the container by over-head tram-rail, was shown—the added cost for the weighing attachment being nominal.

The use of one ton chlorine containers, he said, should not be contemplated when the average consumption is

*L. L. Hedgepeth, Manager, Technical Service, Pennsylvania Salt Mfg. Co., Philadelphia*

*A. E. Griffin, Chemist, Wallace & Tiernan Co., Newark, N. J.*

less than 200 lbs. per day. Rates of gas discharge without artificial heating of the containers could be maintained at 420 lbs. per day, from each container in an atmosphere of 70° F. and air circulation provided for. The lower the temperature the lower the permissible rate of withdrawal of gas.

Mr. Hedgepeth's paper carried in the form of an appendix, a list of first aid measures to apply in case of chlorine accidents or personal injury.

### Evaluation of the Ammonia-Chlorine Process

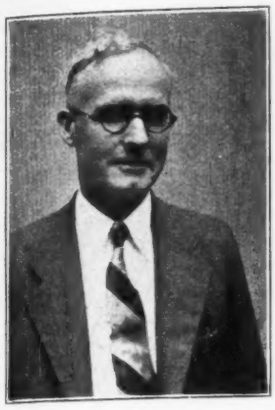
To bring up to date the true status of and developments in the Ammonia-Chlorine process a portion of the program was devoted to that subject.

**"Review of the Status of the Ammonia-Chlorine Process"**—M. C. SMITH, Engineer of Water and Electricity, Richmond, Virginia.

Based on the opinions of many representative men using the process, replies to a specific questionnaire and his own experience, Mr. Smith offered the following summation of the benefits and shortcomings of the ammonia-chlorine process.

(1), As a means of correcting tastes already present in the water *ahead of chlorination,* the process is extremely limited; (2), As a means of *preventing* taste development by the chlorine applied on the secondary formation of tastes and odors in stagnant sections of the distribution systems it was almost universally successful; (3), In the reduction of "dead end" complaints and "red water" or "black water," the process had proved to be of real assistance; (4), For prolonged sterilization it had been far superior to chlorine alone; (5), Was highly efficacious in cleaning filter beds of organic growth and deposits—more so than chlorine alone; (6), The most universally used ratio of ammonia to chlorine had been on the average one to three, but there had been considerable variation; (7), The most used source had been anhydrous ammonia in cylinders;

(8), Prechlorination without ammonia is becoming more generally used and application of ammonia (and more chlorine if necessary) is withheld for the filtered water. Exceptions to the rule, however, indicate pre-ammoniation also advantageous if tastes are produced by chlorination; (9), Although appreciably higher residuals of chlorine could be carried to the consumer when using the process, there are definite upper limits which seem to vary with the quality of the water and seasonal conditions, including temperature; (10), Practically no in-



*John R. Baylis, Chicago*

*George D. Norcom, New York City. Chairman, Water Purification Division*

jurious or deleterious effects had come to light and the process seemed firmly established in one or another form; (11), The orthotolidin test for residual chlorine was likely to be less accurate when using the process. Particularly was this true at low temperatures at which the test revealed lower residuals than actually existed. The latter possibly accounted for some of the variation in reported tolerance of consumers to various residual values in tap samples.

HARRY E. JORDAN stated that the carrying capacities of pipe lines had increased somewhat following the introduction of ammonia-chlorine treatment. The use of pre ammoniation entailed increased usage of materials and economies had been effected at Indianapolis by postponing the ammonia addition until after filtration.

**"A Study of the Bacteriacidal Efficiency of the Ammonia-Chlorine Process"**—A. E. GRIFFIN, Chemist, Wallace and Tiernan Research Department, Newark, New Jersey.

Mr. Griffin reported on the results of plant scale studies at 3 points in New Jersey in an attempt to evaluate comparative values of chlorine as chlorine and as chloramine, in respect to rate of kill of bacteria and b. coli and the efficacy of residual chlorine when present in each form. Offering the findings as a form of progress report he hesitated to draw hard and fast conclusions which might be applied to all conditions. The results tended to show:

(a), At times relatively high residuals as chloramine or chlorine must prevail in order to completely destroy b. coli in 15 minutes of contact; (b), That 99 per cent or more of the b. coli were destroyed during 15 minutes of contact; (c), For a given period of contact available two to three times the residual as chloramine had to be maintained to equal the same residual with chlorine alone; (d), Alkaline waters require higher residuals or longer contact period for b. coli elimination than do the neutral or acid waters—i.e., waters of pH values 7 and less.

Results on waters of pH value of 7.6 and temperatures of 55° F. indicated that an unfiltered water required chloramine residual of 0.8 p.p.m. to remove b. coli in 15 minutes of contact whereas 0.5 p.p.m. as chlorine (no ammonia) did the same job. With a 2 hour contact, however, 0.4 p.p.m. chloramine residual was equally effective and compared with 0.3 p.p.m. chlorine residual. Interestingly, but 0.15 p.p.m. chloramine residual was required to destroy 99.5 per cent of the b. coli within 15 minutes—the resistant minority accounting for the additional 0.65 p.p.m. requirement for a rapid kill.

At another plant (pH 6.9), 0.38 residual chlorine was equivalent to 0.60 residual chloramine within 15 minutes. At the third plant (pH 5.5 to 6.5) there was little to choose between chloramine and chlorine 0.2 and 0.3 p.p.m. being effective in 5 minutes of contact to eliminate all b. coli. In reply to a question, Mr. Griffin thought that comparative efficiency would be obtained with residualsh twice as high when using the ammonia chlorine process. With reasonable (economical) residuals a contact period of roughly 2 hours seemed to be required to completely eliminate all b. coli.

## Interferences with the Orthotolidin Test

Dr. A. M. Buswell, scheduled to present a paper on the effects of manganese on the orthotolidin test and means of overcoming the difficulty did not appear and no paper was sent in. On the second problem—that of nitrate interference—the following paper was read by F. W. Herring in the author's absence.

**"Interference of Forms of Nitrogen with the Orthotolidin Test"**—ROBERTS HULBERT, Senior Chemist, Filtration Plants, Detroit, Mich.

Mr. Hulbert reported on Detroit experiences in which ammonia applied ahead of filtration had been to a large extent converted to nitrite within the filter bed. The effluent was shown by the revised orthotolidin test, as given in the Standard Methods of the A.P.H.A. and A.W.W.A., to contain residual chlorine whereas in reality the apparent residual was to a large extent color produced by nitrites. The difficulty seemed to be due to the change in the standard method which now called for a 30-minute period of color development after adding the orthotolidin reagent. The presence of chloramine chlorine and nitrites were to be found coexistent in the same water sample which was not possible with chlorine alone. Upon addition of orthotolidin the chloramine chlorine will produce its maximum color in 5 to 10 minutes and at 10 minutes the development of yellow due to nitrite reaction begins to appear but reaches a maximum only after 30 minutes *in daylight*. To preclude nitrite interference it had been found necessary at Detroit to hold the sample *in darkness* during color development and not to allow more than a 15-minute period of contact. The method recommended by Berliner of oxidizing nitrites in the presence of chloramine, with hydrogen peroxide in acid solution, had been tried and discarded as being untrustworthy.

*Norman J. Howard, Toronto, Ont. Director, A. W. W. A.*

Mr. Hulbert warned that nitrites might easily be formed in the distribution system in Summer if ammonia is present and therefore must be watched for in making residual chlorine tests on tap samples. A serious effect of nitrites was found to be the greatly increased chlorine requirement to oxidize them.

**"A Review and Discussion of Papers Comprising the Symposium"**—L. H. ENSLOW, Engineer, The Chlorine Institute, New York City.

Mr. Enslow said that it was difficult to reconcile the claims of nitrite interference with the observation that unchlorinated sewage effluents fairly rich in nitrites fail to produce a color with orthotolidin. However, the period of contact in sewage testing never exceeds 5 to 10 minutes. Where nitrites were excessively high, a brownish color would appear after a 10 minute contact. None the less he agreed that there was no grounds, to his knowledge, which justified the 30-minutes contact specified in Standard Methods. Why the change was made was an open question. He called attention to the recently suggested method by R. D. Scott in the May, 1934, issue of the Journal of this Association, wherein manganese was precipitated by flocking the sample with magnesium hydrate producted from magnesium sulphate and caustic soda. In case nitrites were found, a correction (p.p.m. Nitrite N. X0.08) could be deducted from the maximum reading of apparent chlorine value. The development of color in the dark and a contact period limited to 10 minutes at 20° C. or above should, moreover, render nitrite interference of inconsequential proportions. Manganese interference was to be more seriously considered and the hydrate precipitation method developed by Scott seemed to have certain advantages over other less dependable methods—including the method he had suggested, involving heating to dissipate the chlorine and determining the manganese effect (blank) by testing the boiled, cooled and diluted sample with orthotolidin. The method of reducing manganese with hydrogen peroxide proposed by Adams and Buswell was tricky and had to be carefully conducted to insure complete manganese reduction without destruction of the chlorine present.

Regarding the ammonia-chlorine process, if for no other reason than economy, the ammonia as a general rule should be added after filtration. Fortunately, Detroit was employing prechlorination and therefore the false residuals were not accompanied by a breakdown in plant efficiency.

In commenting on the comprehensive review of the ammonia-chlorine process by Mr. Smith, it was apparent, he said, that a most practical attainment was that of holding in check the biological degradation taking place in "dead-end" mains and sluggish flow sections of the system. The elimination of the necessity of constant bleeding and frequent flushing of dead ends was a matter of consequence to the maintenance department. The reduction of consumer complaints of tastes and discoloration by iron stains and the bacteriological "flare-ups" on the system which occur in warm weather was of great satisfaction to the Chemist and Superintendent of Filtration, who having turned out a fine product at the plant had to "take it on the chin" when it came to the lack of control of subsequent developments at points on the system remote from the plant.

About three years ago, Riddick and Linderman of the U. S. Cast Iron Pipe Company had put forth a claim that much in the way of tuberculation of mains could be attributed to biological phenomena and that chemical attack was not alone responsible. Later, British investigators offered data which served to confirm the claims of Riddick and Linderman. The general report that "red-water" or "black-water" troubles have been materially modified by carrying residual chloramine chlorine constantly to the far reaches of the distribution system might be considered as further proof that degradation of organic matter and corrosion and tuberculation go hand in hand. The results reported from Utica, N. Y., to the effect that a large and long gravity main was holding up if not actually gaining in carrying capacity, since cleaning and introduction of the ammonia-chlorine process at its intake end, was added evidence as to what might be expected if biological control will suppress tuberculation. Further confirmation of these observations would constitute a development of high economic as well as technical importance.

In ammoniation there was a possibility of increased economies and also insurance of rapid effective sterilization if the conditions favored the application of chlorine first and thereafter only that ammonia required to convert the residual chlorine to chloramines, rather than the whole of the chlorine dosage. The scheme might be considered as a form of super chlorination and dechlorination with ammonia. Chlorine being so materially cheaper than ammonia one could use considerably more provided ammonia could be saved thereby. The results would be: greater destruction of organic matter; certain and high bacteriological efficiencies; economy.

In commenting on Mr. Griffin's studies, Mr. Enslow said that the results were a valuable contribution and particularly so since they represented plant scale findings at three different points. The conclusion that twice as much residual chlorine as chloramine was required to do the same work as chlorine alone in reasonable periods of contact (under 2 hours), was in line with observations at other points—particularly in connection with swimming pool chlorination. The studies of Mr. Griffin had not included waters with very low temperatures or waters which had a pH value above 7.8. Since the efficiency of chloramine chlorine was sharply affected by water conditioning (to pH 8.4 or above in softening or corrosion control), and by temperatures approaching freezing, there was need of extending and broadening the work so well initiated by Mr. Griffin, so as to include waters of pH values above 7.8 at low temperatures.

The findings had indicated the value of practicing pre-chlorination and post-ammoniation wherein contact after post-chlorination becomes a matter of little consequence and the "slow but sure" action of the chloramines becomes an asset and not a matter to be fearful of.

Mr. Cox's paper contained much information of value in the matter of available equipment and methods of small supply chlorination. Advice as to stabilization of hypochlorite solutions with alkali was timely and there was now available a dry ready prepared mixture (H.T.H. 15) which contained the proper proportion of soda ash and calcium hypochlorite to produce a stabilized solution of sodium hypochlorite. Mr. Cox had not listed the Phipps-Bird solution feeder as an automatic or semi-automatic device but it was adaptable to such use in connection with automatic pumping equipment and on variable flows also.

In connection with hypochlorite solution feed it was feasible to do two jobs at one time—i.e., add alkali for pH adjustment along with the chlorine through a single feeder. For the same purpose there seemed no good reason why hydrated lime and hypochlorite might not be mixed in the correct proportion for dry feeding—i.e., dry dilution of hypochlorite with lime. In small supply treatment it was always preferable to have a reservoir or tank in the system, so arranged to have the water pass through the reservoir rather than have it merely floating on the system. By this scheme a more dependable result and uniformity of product would be secured at consumer's taps.

Mr. Enslow complimented Mr. Hedgepeth on his valuable and needed contribution. The ton-container vault with connections from it to the chlorinators seemed to be a very practical safety scheme.

# N. Y. STATE SEWAGE WORKS ASSN. MET AT JAMESTOWN, N. Y.

THE New York State Sewage Works Association held its Spring Meeting in Jamestown, New York, June 15-16, 1934, President E. B. Besselievre presiding. One hundred and seven members and guests were registered. Nineteen manufacturers displayed instructive exhibits.

## Technical Sessions

(E. B. Besselievre presiding)

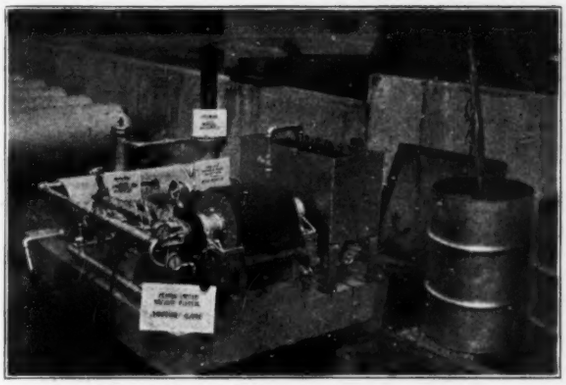
Henry Ryon, Sanitary Engineer of the State Department of Public Works, in an illustrated talk, described the activated sludge plant at the Harlem Valley State Hospital, a very compact plant utilizing Simplex aerators and many automatic mechanical devices. Discussion was opened by E. M. Jones of the Simplex Valve & Meter Co. and W. B. Marshall of the Chain Belt Co. The paper of timely interest on the "Present Aspects of Chemical Treatment of Sewage and Sludge," by J. H. Brendlen of the Calco Chemical Co., was interestingly discussed by L. L. Hedgepeth of the Pennsylvania Salt Co. Many questions from the floor followed.

At luncheon, the Hon. Leon F. Roberts, Mayor of Jamestown, cordially welcomed the convention to Jamestown and M. T. Patchin, Chairman, Committee on Exhibits, presented a review of manufacturers' exhibits and introduced representatives in charge. Products exhibited were briefly described.

At the afternoon session A. E. Stilson of the Morse Boulger Destructor Company presented a scholarly (illustrated) paper on the "Disposal of Sewage Solids by Incineration." The discussion, which was opened by Wm. Raisch of Oliver United Filters, was followed with considerable interest. The paper by Thomas Heubi giving experiences in "Sewage Treatment at Fredonia" was discussed by A. F. Allen, District Engineer of the State Health Department at Buffalo, who also spoke of recent operating difficulties in handling acid iron wastes at several of sewage treatment works since the return of industrial activity to the Buffalo area. Earl Devendorf, Associate Director of the Division of Sanitation, State Health Department, presented a timely paper on the "Status of Federal Aid for Sewerage and Sewage Treatment in New York State" and answered many questions from the floor.

A paper on "The Mechanical Filtration of Elutriated Sludge," prepared by C. E. Keefer and presented by Herman Kratz, Jr., of Baltimore, of unusual interest to all, was discussed by E. B. Besselievre and L. H. Enslow. Wm. Gavin Taylor, Consulting Engineer, Newark, N. J., presented an "Abstract of Operating Results at Rockville Centre," which was discussed by C. C. Agar of the State Health Department.

The evening was devoted to a boat ride on Lake Chautauqua with dinner and dancing at Bemus Point, returning to Jamestown at midnight. Friday afternoon the ladies enjoyed an automobile tour around Lake Chautauqua, including a visit to the Chautauqua Assembly grounds and tea at St. Elmo.



*Sludge Dewatering Demonstration Unit at the Jamestown Sewage Treatment Plant, Dewatering Digested Sludge.*

A large number attended the now famous "Sunrise Breakfast" on Saturday morning, at which Morris Cohn conducted the question-box and round-table, where many problems were settled to the satisfaction of all. Leland L. Graham, Director of Public Works, briefly described the Jamestown Sewage Treatment Works and the group then proceeded to the treatment plant. Here was witnessed an excellent demonstration of the vacuum filtration of sludge conditioned with ferric chloride and lime, which was arranged by W. H. Pitkin, Engineer, Oliver-United Filters.

The following manufacturers were represented:

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|---|---|
| Innis Speiden & Co. | American Brass Co. |
| Buffalo Slag Co. | The Dorr Co., Inc. |
| Robinson Clay Products Co. | Hallenbeck Testing Laboratory |
| Phipps & Bird, Inc. | Oliver United Filters |
| The Chapman Valve Mfg. Co. | Chain Belt Co. |
| Shelt Co. | Westons' Gasket & Form |
| Pittsburgh Equitable Meter Co. | Bailey Meter Co. |
| Chicago Pump Co. | Wallace & Tiernan |
| The Carborundum Co. | Norton Co. |
| Row Engineers | Fayar Corporation |

The Fall Meeting of the Association will be held at Oneonta early in October.

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ST. LOUIS WATER WORKS HAD $680,670 PROFIT.—The Water Works Department of St. Louis ended the fiscal year, April 9, with a balance of $680,670.65 above operating expenses. Receipts of the Water Department aggregated $3,798,803.65. Operating expenses were $3,118,133, divided as follows.

*Snapped on the N. Y. S. S. W. A. Boat Ride on Lake Chautauqua, N. Y. Jimmie Angell Was Inspired; He played "Angellically" While the Resolutions Committee (Extreme Right) Resoluted in the Bow.*

# EDITORIALS

## *Special Sprinkling Rates*

ENCOURAGING the use of more water is attracting the attention of an increasing number of Water Works Managers in charge of systems that have the required surplus water to offer and distribution systems capable of standing some addition to existing peak loads. Involved in this scheme is the attraction offered the consumer or user in the nature of reduced rates on all excess water used above his normal consumption. The greatest increase in domestic consumption which comes as a result of the establishment of such reduced rates is brought about through a liberal use of water for lawn, garden and sidewalk or street sprinkling. Such rates are frequently referred to as "special sprinkling rates."

Before the recent Convention of the American Water Works Association, R. B. Simms, Superintendent of Water Works at Spartanburg, S. C., outlined such a scheme recently put into effect by his Department, as reported elsewhere in this issue. In answer to criticism from the floor, by those who considered such reduced rates as an illegal discrimination and by others who argued the dangers of overtaxing the system by the increased peak loads, Mr. Simms answered in few words but much to the point. He replied, that Spartanburg had the water; the people wanted it for sprinkling; and, they were going to let them have it. In a nut-shell the reply by Mr. Simms is the answer to the question of the soundness of establishing special rates for increasing water consumption. At what price the water can be sold for, without loss to the Water Department, becomes a matter of book-keeping. The only true cost is the operating cost of pumping and purifying the additional volume consumed. Such cost may be found to be considerably less in cases than the half-normal rates charged by Spartanburg. When the available public supply is sufficiently in excess of normal consumption and when the purification plant, the pumping facilities and trunk mains are oversized for the normal present day consumption, there is good argument for making use of surplus supply and plant capacity for the mutual benefit of both the Water Department and the consumer. Further, even the taxpayer stands to benefit.

There was no argument presented to show the intangible value which lawn sprinkling possesses and which must bring indirect returns to the city treasury. The "city-beautiful" is the attractive city—attractive to tourists who leave money behind, to realtors seeking attractive locations for development, to manufacturers who on visits or tour have been impressed with the pride of the community's home owners—always a good sign of a location where employees will be contented and stable. The same industrialist may be attracted by the availability of surplus municipal water at the special (but not money losing) rate for his own needs. As a fact it has been expedient for municipalities, in some cases, to supply industrial water at sufficiently low rates to cause abandonment of privately owned industrial supplies.

Special rates for lawn and garden sprinkling, where feasible, have justification beyond a mere weighing of direct gain; and, in fact, it would not be difficult to argue the justification at a net loss in order to procure beautification of the city at a very low cost to the taxpayer who benefits in the end. Some water companies have found that it pays to employ a professional landscape artist to encourage beautification of private properties, the justification being an increased water consumption created by sprinkling. One method returns cash dividends to stockholders—the other, intangible interest to taxpayers.

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## *Reservoirs and Recreation*

EVER so often the question of whether or not reservoirs and water-shed areas on municipal water supply systems should be put to recreational use comes up for discussion. Sanitarians argue that there is always the potential hazard of introduction of dangerous pollution as the result of careless and thoughtless recreationists. There may be other grounds for argument against the practice, but the most substantial is that on aesthetic grounds the public prefers not to have its drinking water exposed to pollution by "Tom, Dick and Harry" regardless of the assurance that subsequent purification will render the supply safe. That the latter is correct requires no argument, but the question of tolerance of practice must in the end rest with the citizens of the community. For example: one finds a mid-western city using its raw water supply reservoir as a public bathing place at a point within sight of its filtration plant. In other localities the reservoirs are purposely not stocked with fish for fear that they may be trespassed by fishermen; and, still others prohibit hunting and fishing on the water shed areas by having the area created a game preserve and manned by wardens.

Privately owned water companies can not take the chances of incurring the ill will of its customers by conceding to the wishes of a minority—or even a majority—in the matter of allowing its sources of supply to be used by the public generally for fishing, boating or bathing. The choice of the majority, however, can and should be conceded to in cases of municipal ownership and *regulated* recreational use of publicly owned or controlled reservoirs and water shed areas becomes a valuable asset to the community—a marvelous creator of good will toward the Water Department. It has been the experience of Water Works managers that the establishment of recreational grounds by the Water Department has paid well in turning growlers into boosters. Most particularly has this been shown in a tangible way when one compares the attitude of the consumer facing the teller's window in the Water Works office before and after he has come to feel that "now he is getting something for his money." It all goes to show that water is such a common-place material that through a meter and faucet it is poorly appreciated—at least not until it fails to flow when the dishes need washing or the breakfast coffee needs to be brewed. In an attractive lake, over a waterfall, in a swimming pool and particularly under a boat containing tackle and bait, water becomes more intimate, more alluring, more romantic. If by mixing romantic, recreational and utilitarian water one can produce a more valuable, more appreciated product; why, then, is that not the thing to do.

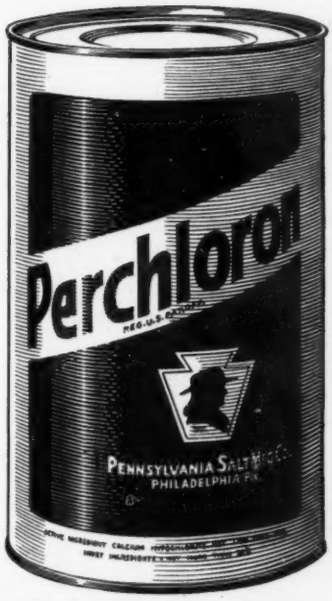
*Plant of Pennsylvania Salt Mfg. Co. at Wyandotte, Mich.*

# Perchloron

## *Made in Wyandotte, Michigan*

**Perchloron is an American product—made in an American plant for American users. Its quality is always uniform. Leading municipal and private pools are using Perchloron because it means greater safety . . . and because you can easily use it in any pool, regardless of size. Furthermore, this new, highly concentrated powder tests over 70% available Chlorine.**

**The stability of Perchloron is unquestioned. You always get a uniform solution. It is easy to use . . . requires no costly, technical supervision and comes conveniently packed one dozen cans to the case.**

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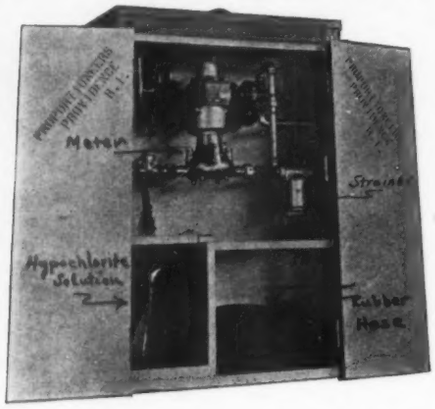
# NEW EQUIPMENT AND MATERIALS

## *The Chlor-O-Feeder*

For the express purpose of providing a fully automatic, rugged, dependable unit for feeding chlorinating solutions made from hypochlorites (H. T. H., Perchloron, etc.) or solutions of ammonia or sulphate of ammonia, the CHLOR-O-FEEDER has




*The Clor-O-Feeder in Portable Cabinet*

been developed by Proportioneers, Inc., 9 Codding St., Providence, R. I.—this firm now being associated with Builders Iron Foundry.

The CHLOR-O-FEEDER consists essentially of an actuating water meter which controls the speed of operation of a specially designed TRET-O-UNIT. As the illustration indicates, the assembly is sufficiently compact to be made into a portable, self-contained unit. The basic principle of the CHLOR-O-FEEDER is the same as that of every TRET-O-UNIT, viz: a variable stroke, positive displacement, diaphragm chemical solution pump connected by drive rod to the piston of a displacement water motor. The speed of the latter is governed by a pilot valve operated by the meter mechanism or any other metering device such as Venturi tubes, orifice plates, rotor-meters. Further, a revolving wheel or the motion of a deep well plunger type pump can be used to control the stroking rate of the feeder. The dosage adjustment is made by varying the length of stroke at the diaphragm end.

This feeder is capable of operating against variable line pressures up to 100 lbs. per sq. in. and on any size of main. Nothing but the available water pressure is required to build up the injection head on the feed end of the unit.

Designed on lines successfully employed in the FERR-O-FEEDER, a corrosion-proof feeder supplied Chicago and other cities by Proportioneers for feeding ferric chloride, the CHLOR-O-FEEDER parts are accessible for quick dismantling cleaning and re-assembly. In twin-assembly it becomes a chloramine feeder, feeding ammonia and hypochlorite solutions in exact proportion but at variable rates for treatment of pools or small supplies at any desired point on the system where pressures do not exceed 100 lbs. per sq. in. The mechanical design and materials used in the TRET-O-UNIT will stand the close inspection of the most critical mechanic.

Designed especially for small supplies, swimming pools, sewage plants and for general utility such as main sterilization and the like, on large systems the portable CHLOR-O-FEEDER is especially attractive and may be used as a fully automatic or manually controlled unit.

An interesting descriptive bulletin which reports health department tests for accuracy and effectively describes the CHLOR-O-FEEDER and quotes prices is available for the asking. Address Proportioneers, Inc., care of Builders Iron Foundry, 9 Codding St., Providence, R. I.

▼

## *Improved Columbian Hydrants and Valves*

In a new and well prepared bulletin the Columbian Iron Works (now a division of Mueller Company, Decatur, Ill.) present several interesting modifications and improvements in Columbian fire hydrants and gate valves—all without loss of the simplicity of Columbian equipment. To the hydrant has been added a "self-oiling top," to prevent binding of stem and threads, and a "safety-flange" on the barrel. The latter is a split flange which upon impact breaks on the bottom, thereby safeguarding the hydrant. It can be cheaply and quickly replaced. The valve steam also has a replaceable safety split coupling to preclude breakage or bending of stem.

Columbian valves, with the four point contact feature, have been equipped with an improved and exclusive wedging gate mechanism so designed as to be interchangeable with those in the older type Columbian valves. Stuffing box bolts come plated with corrosion resistant cadmium, making adjustment always easy from above with a socket-wrench.

These interesting improvements are thoroughly described and illustrated in Columbian Bulletin W-34. For a copy, address: Columbian Iron Works, Chattanooga, Tenn., or Mueller Company (Columbian Division), Decatur, Ill.

▼

## WITH THE MANUFACTURERS

### *New La Motte Catalog*

The La Motte Chemical Products Company, Baltimore, Md., announce the readiness of a new supplementary catalog of the well known La Motte equipment and products. Also contained are new items of recent additions to the La Motte line of chemicals and laboratory equipment. Amongst other things the La Motte Company offers to check any outstanding pH standards, or other color standards for accuracy. This liberal offer is made at no cost to the sender. For this service or the new catalog address La Motte Chemical Products Company, 414 Light St., Baltimore, Md. Ask for the "La Motte Supplementary Catalog."

## *Lee H. Williamson Joins Filtration Equipment Corporation*

*L. H. Williamson*

Lee H. Williamson, who for some years has practiced consulting engineering with offices in Richmond and Charlottesville, Va., has recently accepted the position of Sanitary Engineer with Filtration Equipment Corporation, 350 Madison Ave., New York City.

Mr. Williamson has specialized in sanitary engineering for a number of years, having several important water works and sewerage projects to his credit—including those at Charlottesville, Staunton and Blacksburg, Va. On several projects executed under his direction he was associated with Fuller and McClintock, consulting engineers.

In his new work Mr. Williamson will serve Filtration Equipment Corporation on sewage and industrial waste treatment projects involving chemical-mechanical treatment by the Laughlin process.

▼

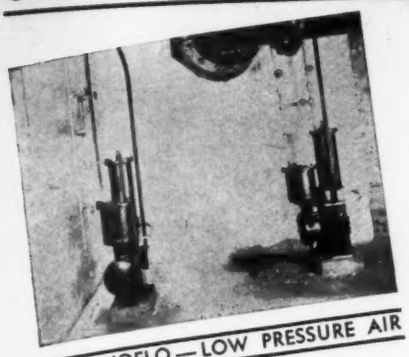
## *Robinson Vitrified Clay Liner Plates*

A new 20-page bulletin has just been issued by Robinson Clay Products Company of Akron, Ohio, which describes Vitrified Clay Liner Plates for industrial and domestic sewers, settling tanks and roofs and walls of masonry structures subjected to degradation by sewer gas and acid production. Inverts of sewers are paved with liner plates to protect them against industrial acid wastes and grit scour.

Made of the same materials as are vitrified clay sewer pipes and for the especial purpose of providing a resistant protective surface to concrete structures, these plates are now increasingly used for this purpose. The Robinson plates are of improved design, employing the dove-tail grooving to "lock" the rear of the lightweight plates into the concrete surface, thus insuring a tight bond. Trued edges allow a hair-line mortar joint and for severe conditions these joints may be made of poured melted sulphur, as was done on the Los Angeles county sewer.

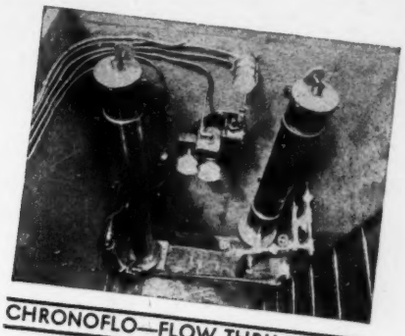
Although we do not subscribe to the claim that "all concrete sewers and sewage treatment structures should be protected with Robinson (or any other) liner plates "there is a definite reason for their use where justified on sound grounds and the bulletin is therefore worthy of study. Address Robinson Clay Products Company, Akron, Ohio, or care of Empire State Building, New York City. Ask for their new bulletin on "Vitrified Clay Liner Plates."

## CHRONOFLO *brings* York Township, Ont., *readings to one point*



CHRONOFLO—LOW PRESSURE AIR

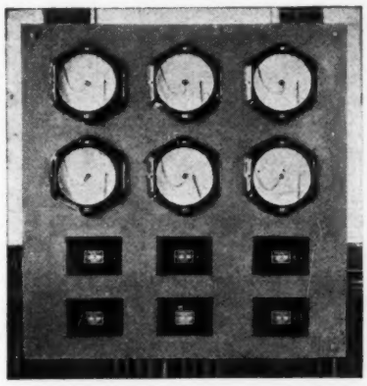
FLOW OVER WEIR



CHRONOFLO—FLOW THRU VENTURI

Proper operation of a modern sewage plant or water works requires constant knowledge of what is happening at widely separated points.

Illustrations show some of the records which CHRONOFLO is taking for York Township sewage plant and transmitting to a central panel so the operator always knows what to do next.



CENTRAL CHRONOFLO PANEL

CHRONOFLO substitutes knowledge for guesswork—whether the knowledge is "hundreds of feet or hundreds of miles" away.

You should have a copy of NEW Bulletin 273.

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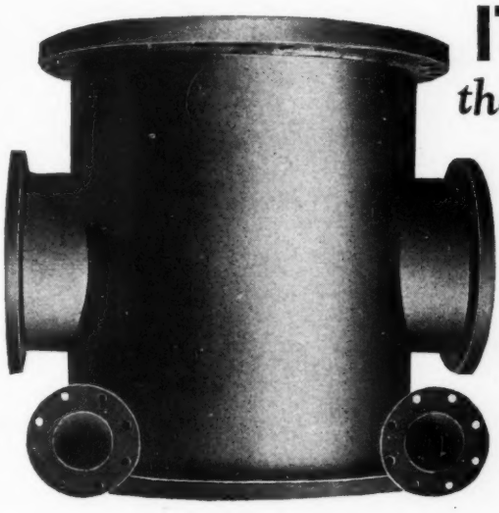

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THE use of Powdered Hydrodarco — the activated carbon for water purification — is the simple, economical, and universally effective method of removing taste, odor and color producing substances from water.

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The advantages of Fence at Waterworks and Sewerage disposal plants are praised by many of the foremost officials who supervise the smooth running of such plants.

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**In the Filter Plant** it is an effective and economical coagulant.

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| Inches | 0 |
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| 0.131 | 37.1% |
| 0.065 | 20.3% |
| 0.0328 | 19.5% |
| Dust | |
| TOTAL | 99.9% |
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COST, using hand labor, less than 30 cents per cu. yd.

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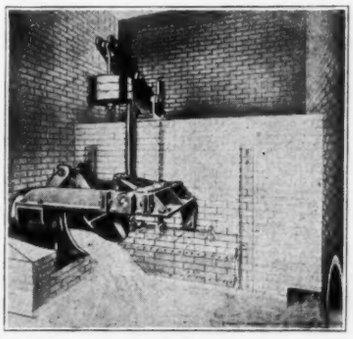

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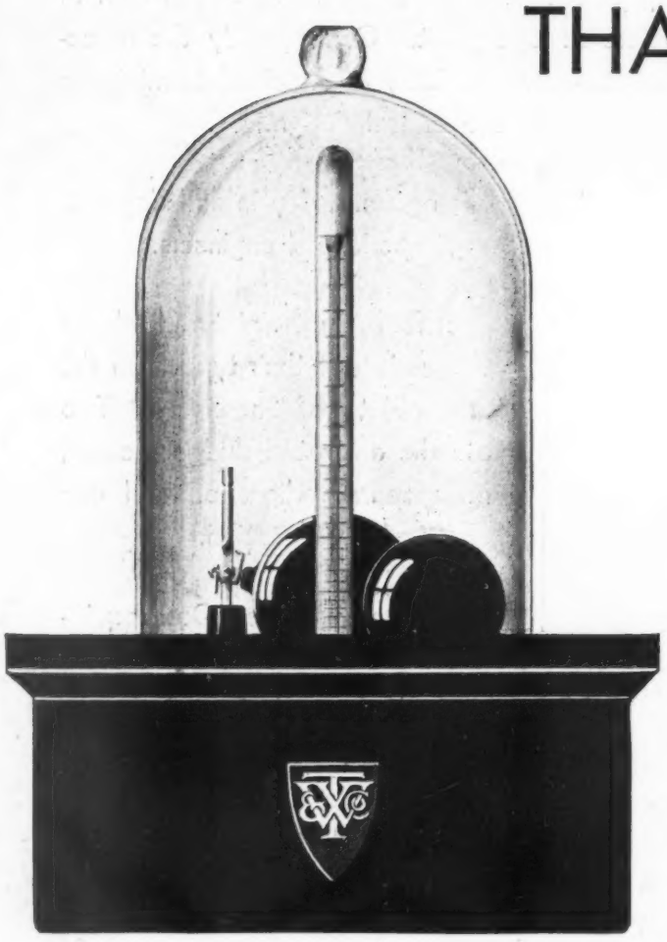

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